

JULY 1976 75 CENTS

Popular Science

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more energy
from the sun

Life on Mars?

The search begins


By Wernher von Braun

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The **What's New** magazine

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PS READERS TALK BACK

Minto's \$10 free booklet

I was very interested in "Wally Minto's Wonder Wheel," which appeared in PS in March. In my enthusiasm, I sent for the "two-sheet paper" on construction details. All I received was a form letter informing me that during the several-month lapse between the preparation of the article and its appearance in the magazine, the two-page paper has grown into a many-paged booklet "complete with plans, specifications," and so on. Also, because of "many months of original research and engineering" it costs \$10. This surprises me since you quoted Mr. Minto in the article as saying that the invention was a "gift to the world."

Tom Schmitz, Portage, Wis.
Many readers were disappointed in not receiving the free information. Wally Minto replies: "Our problem was that we had no advance warning of the flood of inquiries. We had a few hundred two-page reprints on hand and sent those out gratis. But then those recipients wrote back asking individual questions in addition to thousands more initial inquiries and we just got snowed under for two weeks."

"Now, we have had more reprints made of the two-page pamphlets and are sending one to each inquirer, in addition to the letter mentioning the availability of the booklet. Also, everyone who wrote complaining about not receiving 'free literature' was immediately mailed same."

"Incidentally, we've learned that one of the booklet-buyers has received a Canadian-government grant to construct a demonstration wheel at the University of Vancouver. They are enthusiastic over its potential with geothermal heating."

The last frontier

Allow me to give my congratulations on the opening of the National Space Institute to the public. It is a program worthy of the highest endorsement.

Space, being the last frontier, de-

serves a full understanding and a high degree of involvement and inspiration possible only through mass cooperation of the public. The NSI promotes such involvement and will bring the needed support and positive response necessary for successful future space programs.

I have recently been involved in a moderate amount of research of Gerard K. O'Neill's space colonies. A connection with NASA through the NSI would lend greatly to the understanding of such ventures in space. Involvement of excited individuals coupled with other interested parties through NSI would spark new inspiration in the public and produce new speculation and mass acceptance of space programs and their goals. I am glad to have the chance to be part of such a program.

Since the present generation has grown up sated with science fiction that very well may become fact through the work of the space program, the NSI will lay an undercurrent of interest, promoting the programs and giving inspiration for involvement. I believe that the NSI provides an excellent way to involve the people in the future of their civilization.

Paul Bierdeman, Greenville, Ill.

Wobble in the wind

In Ben Kocivar's story on the "World's Biggest Windmill" at Sandusky, Ohio, the NASA people and Louis Divone seem to gloss over the fact that they are getting a lot of wobble on their two-blade-prop windmill. It just mentions that "There are problems of structural dynamics between the tower and revolving blades." What this means to the average layman is a little confusing.

Bill Steele in his article on the same windmill (*Science World*, Dec. 2, 1975) tells a little different story.

Steele reports: "As the propeller spins, you go back and forth from a lot of resistance to none. When the blades are up and down, there is no resistance"

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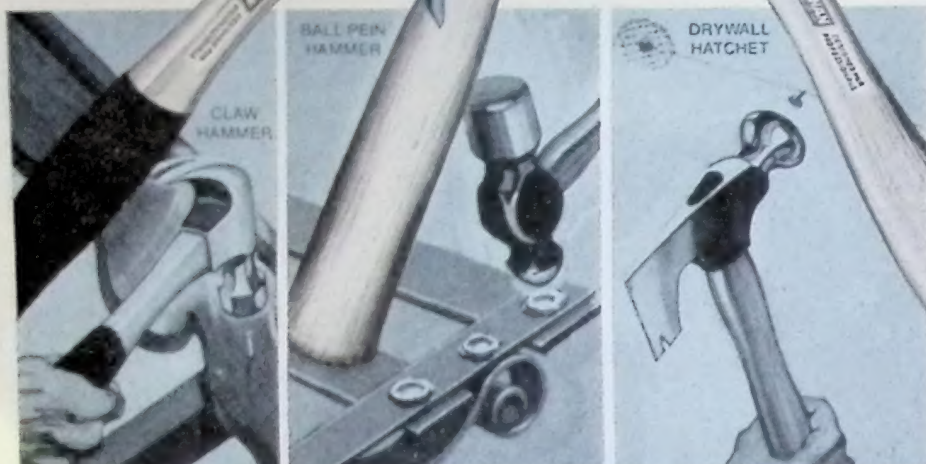
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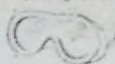
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PS readers talk back

[Continued]

to turning the propeller. When the blades are pointed out sideways, the centrifugal force resists as you try to turn. Since the propeller and pod together weigh 40,000 lb. there are some pretty tremendous forces. You can see the whole pod shaking up there as it turns." He concludes, "We have built enough strength into the tower to take them."

M. L. Jacobs, who is one of the pioneers of wind-energy systems, has said over and over again that you cannot prevent damage to any two-bladed design in shifting directions as the forces of the blade create such centrifugal weight resistance to the direction shifting when the blade structure is horizontal as compared to when the blades are vertical. This action will cause "metal fatigue" of the hub structure in a short time. Grandpa's Knob was a good example of this. Three-blade design gives a smooth action to plane shifting, not possible with any two-blade design.

I had an opportunity to discuss this with Mr. Jacobs when I was in Florida recently. He laughingly referred to Engineer Dick Puthoff's comments in *Science World*. Puthoff had said, "We thought we could show the old-timers how much better we could do it, with our computers and modern materials. But we found out they really knew what they were doing. Our contribution will be to make a wind turbine cheaper."

I was reminded of an article done by E. F. Lindsley of your staff in the July, 1974 article on wind power. In this he stated "... We have yet to find an original idea ... everything that comes up was done 20 or 30 years ago."

It will be interesting to see when and if the bearings burn out at Sandusky and if they are still as enthusiastic a year from now.

John B. Connors, Paterson, N. J.

Anti-tracks

Richard Cornelison advocates the return of tracks, in order to bring back the benefits and blessings of electric-driven public conveyances [RTB, May]. Let us not return to tracks with their attendant hazard to other road vehicles and awkward and dangerous loading and unloading zones.

On the other hand, all the blessings of electric power can be used in restoring the use of the electric bus. The vehicle resembles a bus in every respect except that it takes its power from a dual overhead network of wires.

This system is well-tried and, I believe, eminently successful. It would also enable existing gas-driven vehicles to be converted to electricity at considerable savings, compared with building new street cars.

Those of us who remember the electric bus (and there may be some cities that still have them) will surely applaud any mass return to this system

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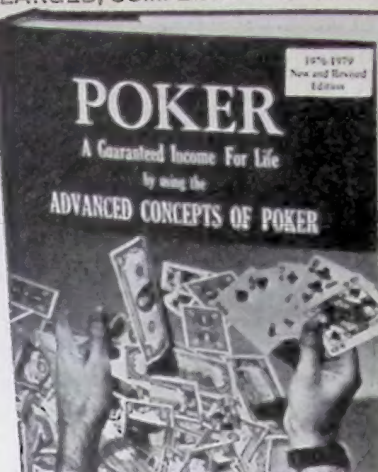
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[Continued]

with its almost silent ride and complete absence of pollution. How about it, you city planners?

Frank S. Wise, Orem, Utah

Which way the grate?

Mr. Davenport [RTB, April] suggests that grate openings in highway drainage grates be placed at right angles to the direction of travel to reduce the hazard to bicycles. Grate openings are placed by highway engineers in line with the flow direction because they are

more efficient thus oriented. They require less depth of water above the grate to intercept the flow and are less prone to clogging by trash.

These findings are based on tests at the St. Anthony Falls Hydraulic Laboratory and are reported in the bulletin "Grate Inlets for Surface Drainage of Streets and Highways," Univ. of Minn., June 1949.

If grates are changed to the right-angle position, the hazard to bicyclists would be reduced, but the hazard to motorists would be increased by the

increased possibility of standing water on the road surface. I would have to choose in favor of the motorist.

W. O. Ree, Stillwater, Okla.

Another greenhouse

I enjoyed Greg Stone's article "Greenhouse Kits for All-Season Gardening" in the April issue. It was very informative and, as usual, gave a good rundown on the choices open to the homeowner.

There was, however, one point about which Mr. Stone was not entirely correct. He gave the per-square-foot price range of these kits as approximately \$7-\$10+. There is an alternative to these arm-and-a-leg prices. The "Geodesic Greenhouse," offered by Seacraft Service Co., P.O. Box 209, Kemah, Tex. 77565 is available in two models, or can be custom-built for only \$4 per square foot (prices are F.O.B. Houston). The smaller model fits against a flat wall or house and encloses 250-plus ft., while the larger is free-standing.

More information is free from Seacraft on these and other geodesic structures out of the future and built to last.

Jack A. Holmgreen,
Seacraft Service Co.,
Kemah, Tex.

Which way, PS?

I generally enjoy your magazine every month. Lately, though, I've been confused as to where you are headed. Your May issue was filled with interesting ideas on solar energy. These articles seemed practical and pro-environment. After looking over these pages I was shocked to read the caption on page 98: "Four-wheel drive gets you into really remote areas. Better have two such vehicles if you're venturing more than 15 miles off-road in desert wilderness..."

What kind of wilderness allows four-wheel drive anything? You have taken the *wild* out of it. With guys as pictured driving around you don't have a wilderness. Four-wheel drive is great for emergencies or snow on the roads or mud on your farm, but please don't encourage it in the wilderness.

What I'd really like to see is your magazine go one way or the other. Make a stand for the environment or don't—please don't tease us with energy-saving water heaters and then send us to the desert in a 4WD machine.

Ms. Joette Weber, Athens, Ohio

PS's stand is pro-environment. We did not mean to imply that four-wheel-drive vehicles be used indiscriminately. As author Peterson stated in the article, "Be sure to check with local authorities before driving on such trails; sometimes they are off-limits to motor vehicles."

Want to get something off your chest?
Write "Readers Talk Back,"
Popular Science, 380 Madison
Ave., New York, N.Y. 10017

If one of them says "no," it doesn't leave the factory.



Each person who has a hand in making a Schrade knife also has a hand in rejecting it. Each knife is subject to more than 100 hand operations. More than 100 inspections. If there's a flaw of any kind, the knife doesn't get out the door. That's why you can put your confidence in the ones that do.
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NO OTHER WAGON WORKS HARDER ON A GALLON OF GAS.

As a wagon buyer, you're a special breed with special needs. Try Voyager on for size. It comes with two different wheelbases, plus an extended body version that seats 15 people. Which is three more than any other wagon. Obviously, the more people room, the more cargo room.

26 HIGHWAY MPG, 18 CITY MPG.

That's according to the latest estimated EPA test results on Voyager's Slant 6 with manual transmission. If you don't think those are incredible figures, just compare them with those of any other wagon built anywhere in the world. Your

actual mileage may differ depending on how and where you drive, the condition of your wagon and its optional equipment.

A TURNING DIAMETER 1-FOOT SHORTER?

That's right. 3 feet shorter



than Ford or Chevrolet. Which means tight U-turns and easier parking. Especially with optional power steering. Plus standard power front disc brakes and independent front suspension.

HERE'S "THE CLINCHER"

For the first 12 months of use, any Chrysler Corporation dealer will fix, without charge for parts or labor, any part of our 1976 passenger cars we supply (except tires) which proves defective in normal use, regardless of mileage. The owner is responsible only for normal maintenance like changing filters and wiper blades.



In California, see your dealer for mileage data for California equipped vehicles.

SCIENCE NEWSFRONT

BY ARTHUR FISHER

Message for the future

Last May, NASA launched a spacecraft with a curious fillip: a greeting card to whatever creatures may be inhabiting the Earth some eight million or more years in the future. The LAGEOS satel-



lite is a massy sphere—two feet across but weighing 900 pounds, because its aluminum shell surrounds a solid-brass core. Its surface is dimpled with 426 reflecting surfaces making it resemble a Goliath's golf ball. Its name stands for Laser Geodynamic Satellite, and one of its functions is to monitor, to a highly accurate degree, movements of the Earth's crust. For example, North and South America, carried on vast crustal plates, are moving away from Europe and Africa at a rate of about an inch per year. (For a discussion of con-

tinental drift and plate tectonics, see "Window into Earth" in this issue.)

LAGEOS will be able to measure such motions to better than one inch in thousands of miles. The technique is to hit LAGEOS with pulsed laser beams from ground stations on Earth. (Fourteen such stations should be operating in the 1980's.) The beams are returned by the satellite's prism-like reflectors, the travel times for the return trips are measured precisely, and then converted into exact distances.

To carry out such an exacting mission, LAGEOS must remain very precisely fixed in its nearly circular Earth orbit about 3650 miles high. Its great mass is designed to overcome external influences, such as even faint atmospheric drag, that might disturb its orbit.

In fact, the stability of the craft is so great that its builders (at Bendix Corporation) and NASA believe it will not be braked by the atmosphere to fall back to Earth for at least eight-million years. They realized that here was a unique opportunity to communicate with the future, and called in Dr. Carl Sagan of Cornell University, who had previously designed plaques carried by the Pioneer 10 and 11 spacecraft. These were destined for any potential intelligent life *outside* the solar system. But what to say to our descendants eight-million years hence, creatures who may have evolved into something quite incomprehensible to us, on a planet that will surely have changed a great deal?

The illustration you see here is Dr. Sagan's imaginative answer. The four-by-seven-inch stainless-steel plate displays the numbers one to ten in binary notation at the top, alongside a drawing of LAGEOS and its name in English. To the right, the Earth is shown in orbit around the sun: The arrow points to the right, for the future, and the binary number one indicates one revolution, equalling one year. The three maps below show the drifting continents as they appeared 225 million years ago, as they are today (with the LAGEOS launch shown), and as they are likely to be 8.4 million years from now, with the satellite returning to Earth.

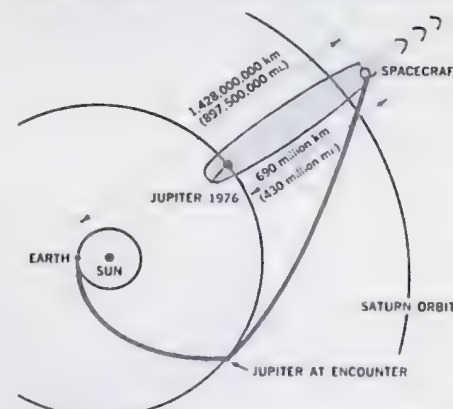
Now won't that be the science story of the epoch?

Jupiter's tail

Speaking of Pioneer 10, that successful space probe is still making news.

It completed the first flight to the vicinity of Jupiter in December 1973, and is now on its way out of the solar system. In early February, it crossed the orbit of Saturn. And what it encountered there, reports Dr. John Wolfe of NASA's Ames Research Center, Mountain View, Calif., is a remarkably long and previously unsuspected magnetic tail belonging to Jupiter. The drawing shows just how long—some 430-million miles.

Magnetic tails are magnetospheres—envelopes of magnetic field—that are stretched out beyond a planet by the impact of the million-mile-an-hour solar wind. Jupiter and Earth are the only planets known to have such magnetic



tails, both believed to be shaped like the tails of comets.

"Jupiter, which has three-quarters of all the planetary material in the solar system, is so huge that such a long tail is understandable," says Dr. Wolfe. Its enormous span, intersecting the orbit of Saturn, means that the ringed planet should enter Jupiter's tail once every 20 years, with some interesting magnetic phenomena in the offing. Date of the next such encounter: April 1981.

Blow-up

This building has just been blown up by the men you see pondering their work—but all in the cause of law and order. They are experts from the Law-



rence Livermore Laboratory, conducting research that is meant to cope with a serious and growing problem—the theft and misuse of dynamite and other high explosives. Dr. James Knowles, at right, heads a team that has determined that "the technology exists to-

Continued

Was every cigarette
you smoked today smooth?

The taste of extra coolness
makes smooth taste
a sure thing with KOOL.

Come up to KOOL.



Warning: The Surgeon General Has Determined
That Cigarette Smoking Is Dangerous to Your Health.

(Continued)

they do the job with less of the hazardous substances that will also be used in the manufacture of explosives from ammonium. The project was supported by the Federal Law Enforcement Agency, Lawrence Livermore Laboratory is operated by the University of California for ERDA.

Miracle mess cleaner

What would happen if a tank truck spewed its load of sulfuric acid or

some equally nasty stuff all over a busy highway? A mess. But now it would be much easier to handle than in the past, thanks to a substance developed by Calspan Corporation of Buffalo, N.Y., for the U.S. Environmental Protection Agency. Called the universal gelling agent, the dry blend of granules can rapidly immobilize 10 times its weight in dangerous spilled chemicals. When sprinkled or blown over an affected area, it interacts with the liquid in seconds to minutes to form a gelatin-like mass that can be

scooped up into containers for removal and disposal. It has been successfully tested against 35 hazardous substances so far, including phenol, methyl alcohol, sulfuric acid, cyclohexane, acrylonitrile, and ammonium hydroxide. Dr. Joseph P. Lafora of EPA's Industrial Environmental Research Laboratory at Edison, N.J., is project officer for Calspan's continuing tests.

Artificial-heart progress

This Holstein calf has been doing just fine, according to a report delivered in early April, with an externally powered man-made heart in place of its own, implanted on December 23, 1975. Key to the new device, according to Dr. Yukihiko Nose, head of the Cleve-



land Clinic Department of Artificial Organs, is a durable pumping mechanism made of polyolefin rubber and developed by researchers at the Goodyear Tire & Rubber Company. The diaphragm has a specially textured surface, which, when covered with a layer of protein, acts as an anchor for developing blood-compatible natural tissue. It may thus avoid the blood clotting that has been the major problem with artificial hearts.

Heart-attack test

Physicians at Lund University in Sweden have developed a simple, immediate, and reliable way to tell whether a patient with severe chest pains is actually having a heart attack. Of the previously available diagnostic procedures, electrocardiograms are not infallible, and a chemical enzyme test takes several days. The new test consists of dipping a specially treated strip of paper in the patient's urine. If he has had a heart attack, the paper instantly changes color, because it reacts to the pigment myoglobin, which is released into the urine whenever the heart muscle is damaged. A patent is pending on the new technique. [E]

Here's The REAL THING

No imitators here. These are the original, genuine CHANNELLOCK tongue-'n-groove pliers. The ones with the smooth-working, machined, undercut mating parts that can't slip out. The ones with the reinforcing flange that practically eliminates stress breakage. The first of their kind and still best of their kind. Be sure you get the real thing. CHANNELLOCK. Look for the trademark on the handle.

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RECREATION ROUNDUP

By HERBERT SHULDINER

Step backward in motorcycle safety

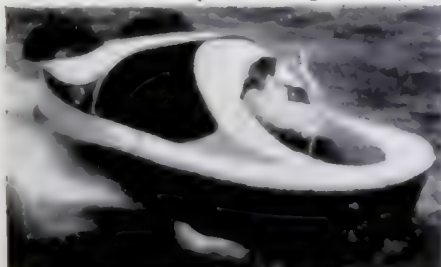
South Dakota motorcyclists will be free to ride without helmets starting next July. Both houses of the state legislature voted to repeal the S.D. helmet law because the federal Highway Safety Act of 1976 prevents the Department of Transportation from requiring the states to have such laws.

Kansas and Connecticut also recently repealed their mandatory helmet laws. While states can still require helmets if they so choose, there's strong evidence that perhaps as many as a dozen other states will join these three in giving motorcyclists freedom of choice. Three states—California, Illinois, and Utah—previously had no helmet laws.

Virtually every study I've seen on the subject points to overwhelming evidence that helmets help reduce deaths and serious injuries from motorcycle accidents. Seems astonishing to me that in view of this, helmet laws are under attack.

Hovercraft plans

You can build the exciting hovercraft shown here from plans being sold by an



Indiana company. The Neova hovercraft was designed by Australian engineer Christopher Fitzgerald.

PS engineering editor E. F. Lindsley says the vehicle is "about the best I've seen, in the control sense." But Lindsley cautions that it will take quite a bit of time to build—about two years, in your spare time.

Cost is likely to run between \$2000 and \$3000, says Lindsley. And you'll have to scrounge for some of the materials that are required to put the Neova together.

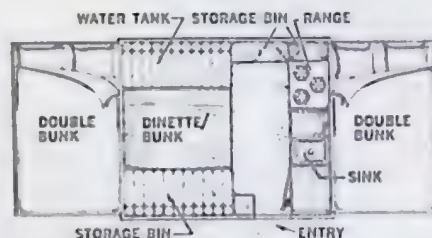
One reservation Lindsley has concerns the complexity of the plans. They may be difficult for a beginner to follow. He also says you need good woodworking machinery, a metal-cutting bandsaw, and gas welding equipment to make the

parts. But if you're game for a challenge, go right ahead.

An information pack is available for \$8 from Neoteric, U.S.A., Inc., Fort Harrison Industrial Park, Terre Haute, Ind. 47804. Complete plans cost \$50.

Camping-trailer plans

This six-sleeper camper can be built from plans available from Glen-L Recreational Vehicles, 9152 Rosecrans, Bellflower, Calif. 90706. The Trail-A-Camp provides for a convertible dinette/double bunk, galley, and two wing bunks. Storage bins are provided under the dinette seats. The camper has a steel frame



and steel-studded sidewall. Price of the plans is \$10, postage prepaid.

Travel-trailer overloading

The National Highway Traffic Safety Administration recently issued a special advisory to owners of travel trailers, urging them to inspect their rigs for possible overloading. NHTSA says it issued the special advisory because "some travel-trailer manufacturers—even those with models especially susceptible to overload—have failed to initiate any effort to alert owners to the overloading danger."

The agency, however, says that Blazon, Coachmen, and Shasta have begun to alert owners of trailers to the problem, so that they can recognize the overloading hazard.

Meanwhile, NHTSA says that it is attempting to identify all trailers that offer "very little or no" cargo capacity before exceeding the trailer's maximum suspension-system load rating. The investigation has initiated eight recalls so far, according to NHTSA. Trailer makers involved in the recalls have replaced

tires, wheels, or axle systems with higher-load-capacity components.

NHTSA advises, also, that if you own a travel trailer, especially an older model, you should learn how to load the rig to prevent suspension imbalance. It says many travel trailers have too much or too little load on the rear axle of the towing vehicle. It also says that 59 percent of trailers it surveyed had underinflated tires.

NHTSA says if you have suspension problems with your trailer, or need help in determining the load capacity of your rig, write its Office of Consumer Services, 400 7th St., S.W., Washington, D.C. 20590. NHTSA also has a safety hot-line phone serving a 10-state east-coast area. The toll-free number is 800-424-0123.

RV and van cooler



Designed for use in areas where temperatures are high and humidity is low, this new evaporative cooler from the Coleman Co. is capable of reducing interior temperatures of vans and recreational vehicles by 10° to 20°. The Polar Cub cooler has a roof-mounted unit that's a shade under six inches high, to help reduce wind drag. The interior control panel and fan unit reduce head room by 2¼ inches. The water reservoir is designed for housing in a cabinet or bin. Price of the cooler with water reservoir is \$189; without, it's \$153.

Rentals for campers

Want to rent a motor home when you're out of town? AAA Motor Home Rentals, 2361 South Main, Salt Lake City, Utah 84115, will tell you about rigs that are available for rent from commercial and private owners. The firm also maintains a toll-free number, 800-453-5747, to inform you. A search fee of \$10 is charged for this service. The center will also process reservations.

More than 120 Kampgrounds of America locations now rent 9-by-12 tents. Don Ryan, KOA vice president, says rental fee is \$9 per night for a tent with four cots or air mattresses. Extra cots cost a dollar each.

You need your own sleeping bags, or blankets and sheets, and pillows. You can get a leaflet on the KOA tent-rental program by sending a stamped, self-addressed envelope to KOA, P.O. Box 30558, Billings, Mont. 59114.



If you ask your pickup to be more than a pickup, ask for a GMC.

The days of the good ol' hard-nosed no-nonsense pickup are numbered. Because today's pickups are being asked to do more than just an honest day's work.

They're being asked to do what the family car does.

They're also becoming involved in more and more purely recreational pursuits. And they're even becoming motorized works of art.

Well, if you're not already part of this trend, we suggest you drop by your GMC dealer. He's a truck expert. Which

means he can do a lot more than just sell you a pickup.

He can help you set up your GMC any way you want it.

He'll help you select the right engine, tires, axle ratio, and springs. He'll help you prepare your GMC for any special trailer-towing chores. Or to carry a camper.

But no matter how you equip your pickup, the important thing is that your GMC dealer is giving you such a solid truck to begin with. One with double-wall construction in the cab and pickup box.

Independent front suspension. High-Energy Ignition. And a roomy, comfortable cab, either 2- or 4-door, with lots of glass area and little niceties like padded armrests and visors and a continuous flow-through ventilation system.

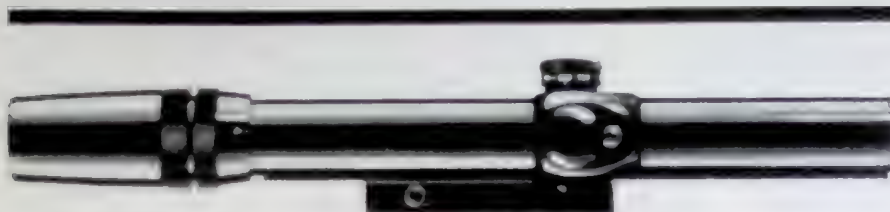
Yes, a GMC is a fine pickup. It should be. Because it comes from people who've specialized in trucks for over 70 years. In other words, if you're itching to get in on America's growing love affair with the pickup, your GMC dealer is the logical place to go.

THE TRUCK PEOPLE FROM GENERAL MOTORS



ON TARGET

By PAUL WAHL



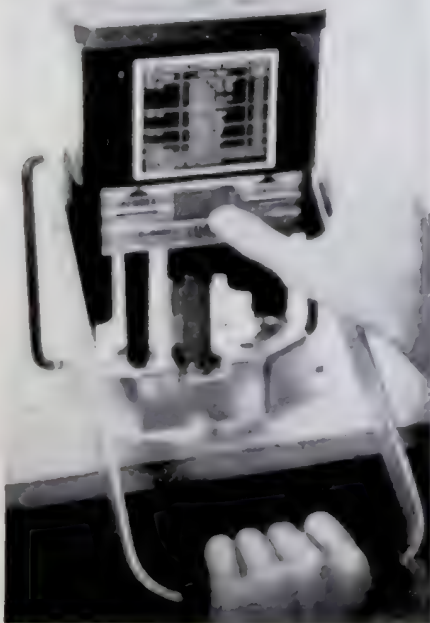
No more hold-over

Guessing how much to hold over the target on long shots is a real problem to most shooters. Bushnell Optical Co. 2828 E. Foothill Blvd., Pasadena, Calif. 91107) solves it with the new custom .22 Rangemaster Riflescopes.

A bullet-drop compensator is built into the scope's elevation-adjustment knob. You just dial the range and put the crosshairs where you want the bullet to strike. The 4X fixed-power model is \$21.95; the 3X-7X variable (above) is \$26.95. A dovetail mount fits standard grooved receivers.

Reloading saves

Shotgunners can save 60 to 70 percent—as much as \$5 on a box of 25 shells—by refilling their empties. It costs only 6½ to eight cents to reload a 12-gauge shotshell, and the hull may be reused as many as a dozen times. Now reloading is practical, even



If you're only an occasional shooter, with the new, low-priced easy-to-use Lee Load-All (pictured above). You don't need to make adjustments, and the "recipes" are printed right on the front of the machine. It comes completely assembled, factory set, and ready to start turning out loaded and reloaded shells at up to 200 per hour.

The Load-All costs only \$29.98 (there's no competition at anywhere close to that figure), which can be recouped on the first six to 10 boxes you load. Only the 12-gauge model is currently available; tools for other gauges will follow soon. If your dealer doesn't have the Load-All, you can order one direct from Lee Precision, Inc., Highway U, Hartford, Wis. 53027.

Lower-priced over/unders

Typically, today's over/under shotguns sell for upwards of \$400—with "upwards" going well over \$2000. Harrington & Richardson (Industrial Row, Gardner, Mass. 01140) has just introduced a nice pair of O/U's at more modest prices: \$299.50 for the Model 1212 field gun, \$335 for the waterfowl gun. Both 12-gauge shotguns have ventilated-rib barrels, selective single trigger, automatic safety, extractors. The field gun has 28-inch barrels with 2¾" chambers, choked-improved cylinder and improved-modified; the waterfowl gun has 30" barrels with 3" chambers, choked-modified and full. The latter is fitted with a recoil pad to soften the magnum kick.

Winchester-Western (275 Winchester Ave., New Haven, Conn. 06504) now offers a less-costly and plainer version—no engraving—of its popular Model 101 over/under gun. Designated the Xpert Model, it sells in field grade for \$475. The skeet gun is \$485; the trap gun \$490 (\$495 with Monte Carlo stock).

Instant collector's items

Since the Sixties, commemoratives have provided a new interest for gun collectors. This year, several special limited-edition versions of popular guns

have been issued to commemorate the Bicentennial:

- Ithaca's Bicentennial Model 37 pump shotgun is offered in 12 gauge, with 28-inch ventilated-rib barrel, modified choke. Its receiver is etched and handworked with an American eagle on one side and, on the other, "1776—American Bicentennial—1976" and "The right of the people to keep and bear arms shall not be infringed." Serial numbering is from "USA 0001" to "USA 1976." Stock and slide handle are of fancy walnut, hand-checked. Priced at \$500, this shotgun comes in a luggage-type carrying case and is accompanied by a cast-pewter belt buckle engraved with the same eagle design and serial number. Ithaca Gun Co., Terrace Hill, Ithaca, N.Y. 14850.

- Bicentennial offerings from Remington Arms Co. (Bridgeport, Conn. 06602) include: 12-gauge skeet- and trap-grade shotguns, Model 1100 auto at \$284.95 up, Model 870 pump at \$219.95 up; .30-06 rifles, Model 742 auto at \$244.95, Model 760 pump at \$214.95; .22 auto rifle, Nylon 66MB at \$84.95 up. On their left receiver panels, the commemoratives are inscribed



in gold coloring with the American colonial eagle, and the legend "1776-1976"; otherwise they're the same as standard models costing \$5 less.

- Winchester-Western (275 Winchester Ave., New Haven, Conn. 06504) has issued a special fancy version of its well-known Model 94 lever-action .30-30 carbine in a limited edition numbering less than 20,000. The Winchester Bicentennial '76, at \$325, has its receiver decoratively engraved and finished in antique silver. An American eagle adorns the left side of the receiver; on the right side is "76" encircled by thirteen stars. "Bicentennial 1776-1976" is engraved in script on the right side of the barrel. The wood is American walnut; forearm and grip are nicely checkered, and there's a nickel-silver commemorative medallion embedded in the right side of the buttstock.

New books

From Winchester Press (205 E. 42nd St., New York, N.Y. 10017), these titles belong on every gun enthusiast's bookshelf:

- *The History of Winchester Firearms, 1866 to 1975*, by George R. Watrous, describes and illustrates every Winchester from the earliest to the latest. 229 pages, slipcased, \$15.

- *The Modern Rifle*, by Jim Carmichael, Shooting Editor, *Outdoor Life*, is easily the most complete and up-to-date volume on the subject. 342 pages, illus., \$12.95.

23

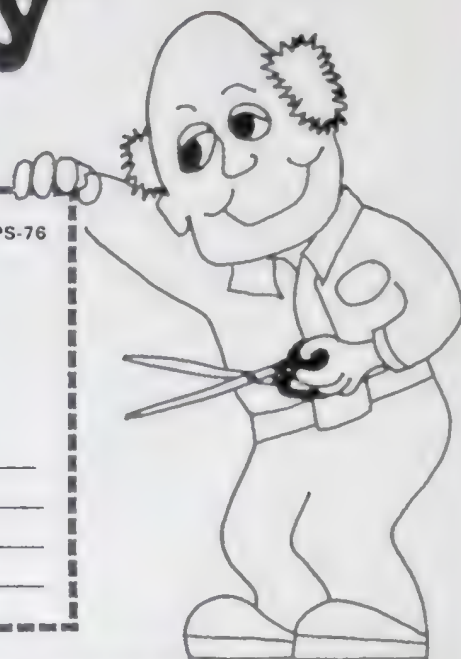
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PS-76



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As the nation's largest network of foam insulation specialists, the Homefoamers can offer you quick, reliable, and experienced service that you can depend on.

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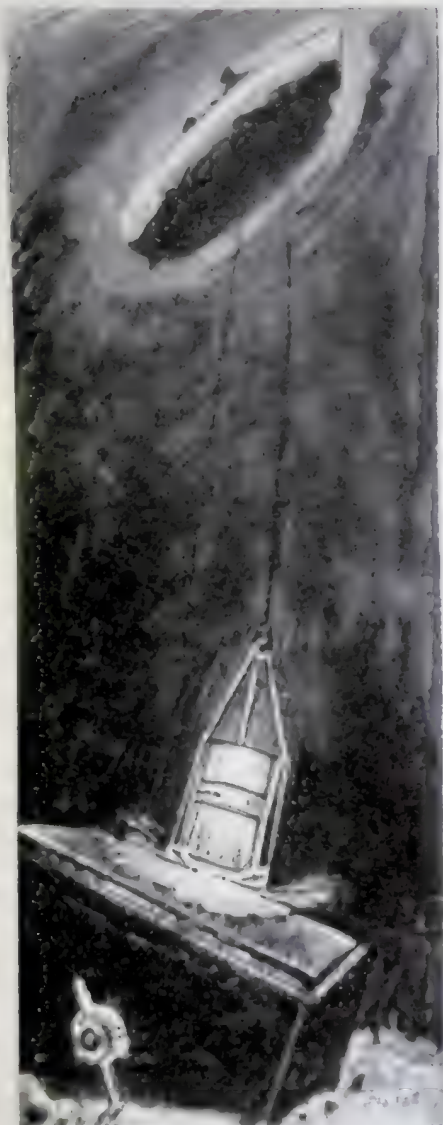


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America's largest network of foam insulation specialists.

NEW IDEAS FROM THE INVENTORS

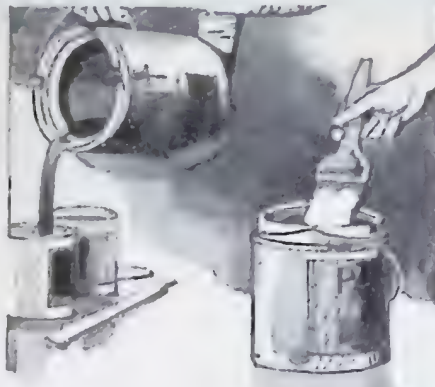
ILLUSTRATIONS BY HERB MOTT



Explosive weld aids in salvage

Lowered from a salvage vessel, this magnetized housing would seek out ferrous items on the ocean bottom, or might be positioned by a diver on other metallic objects. An explosive powder in the base would then be ignited electrically from above. It's said the intense, concentrated heat would weld the two surfaces, making it easier and more economical to attach and raise targeted items. Two or more of the units could be used to salvage larger masses.

The following patents have been issued on these inventions: Salvage aid--No. 3,871,315 to Leonard M. Anderson, Yonkers, N.Y.; Houseboat driver--No. 3,815,541 to Clarence C. Hansen, Bonner Springs, Kans.; Traffic director--No. 3,798,597 to Glenford Lilly, Mesa, Ariz.; Point pourer--No. 3,811,606 to Jerome C. Higgins, Phoenix, Ariz.



Can lip pours, drains paint

Snapped into the top groove of a paint can, this plastic ring would let you pour paint without losing any to the groove or to messy, label-obscuring drips. Used as a brush wiper, it would flow excess paint back into the can. Slots in the ring would let you pry it out for clean, air-tight resealing with the regular lid.



Nested launch drives houseboat

Locked into a front-opening well within the hull of a houseboat, a small power boat could drive the larger vessel or move out for independent use when the houseboat was docked. Its forward location might improve maneuverability and would permit rear beaching of the larger craft. The retaining frame within the houseboat would be made longer than the launch, providing a choice of tow positions. A hatch above water level would allow passage between the boats.



Tensioned lines assemble walls

Lightweight plastic panels might be easily assembled into a playhouse, camp or beach shelter with this line-tensioning system. End-knotted cords would be strung through matching holes in facing panels. The bent-wire tensioner would be looped over the line, twisted tight, and locked under the line.



Mobile director speeds traffic

Ordinary traffic lights may not provide adequate control at some intersections during peak hours, says this inventor, or may not be available at other locations (outside a fairground, for example) because of infrequent need. To meet both situations, he'd move this rotating-arm director into position as needed, set its motor to extend and turn the outstretched arms. They'd provide clear, sequenced directions for stopping, turning, circling and passing traffic.

Line tensioner--No. 3,879,805 to Joseph C. Gretter, Wilton, Conn.
Copies of patents can be ordered by number, from the Commissioner of Patents and Trademarks, Washington, D.C. 20231, at 50 cents each. To write to an inventor, if address above is insufficient, address him by name and patent number in care of the Commissioner.

TASTE THE GOOD TIMES. RALEIGH



Warning: The Surgeon General Has Determined
That Cigarette Smoking Is Dangerous to Your Health.

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Zippo lighter with Raleigh coupons, the
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You'll remember Raleigh. The genuine tobacco flavor. The valuable gift coupons.

Filter Kings, 16 mg. "tar," 1.0 mg. nicotine; Longs, 17 mg. "tar," 1.1 mg. nicotine, av. per cigarette, FTC Report Nov. '75

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DATSUN

KING



DATSUN'S NEW DELUXE PICKUP HAS ALL-NEW CREATURE COMFORTS.

King-sized cab features more legroom and luxury than any other small pickup (more than some full-sized trucks). Plus a foot of storage space behind the seats.

WORLD'S FIRST

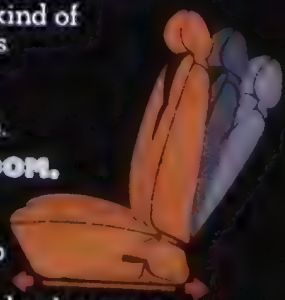
Meet the newest, roomiest and most comfortable small pickup around. Datsun's all-new Li'l Hustler Deluxe. It's all decked out with the kind of innovations and features you'd expect from the maker of America's #1 Selling Small Pickup.

GARGANTUAN LEGROOM.

We stretched out the cab to give you more stretch-out room. And to keep you comfortable, we put in fully reclining bucket seats (no other pickup in the world has 'em).

TREMENDOUS INSIDE STORAGE SPACE.

Behind the seats, there's up to 11.3 cu. ft. of usable space for things like groceries,



PRESENTS

CAB



TM

BIG CAB IN SMALL PICKUPS.

golf clubs, or a toolbox full of monkey wrenches. (Sometimes it's nice to stash stuff inside when the weather's not nice outside.)

COLOSSAL HALF-TON LOAD BED.

All that room in front doesn't mean you don't get room out back. Our new Deluxe still hauls a full half-ton of cargo. So you can keep on trucking and have your comfort, too.

VERY CIVILIZED COMFORT.

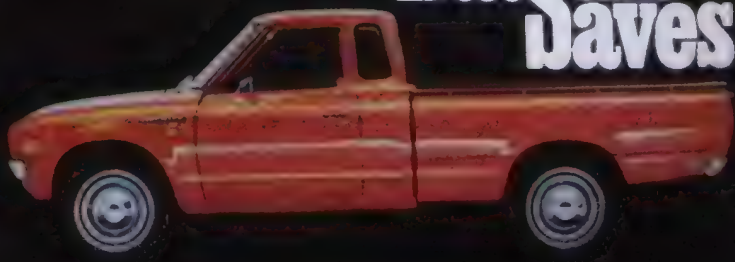
Besides plush bucket seats, KING CAB™ comes with lots of other extras that don't cost extra. Like full carpeting, console, even little things like a package tray. Because little things mean a lot. If you want even more creature comforts, air conditioning and an automatic

transmission are available.

See the new Datsun Deluxe with the roomy KING CAB, along with Datsun's other two fine pickups (alias Li'l Hustler Standard and 7-ft. Stretch).

NOW SHOWING AT YOUR DATSUN DEALER.

Datsun Daves



DETROIT REPORT

By JIM DUNNE

More on rectangular headlights

The 1977 intermediate sedans from Ford, Mercury, Dodge, and Plymouth will have them. The over-and-under style will predominate, with all but Mercury among the new models going that way. Auto manufacturers claim that the advantages of rectangular headlights are a more precise light pattern and the ability to build hood lines lower. But the real reason could be styling. Some designers feel the rectangular shape looks more attractive than the round.

Chevy loses weight

Weight reduction of from 550 to almost 1000 pounds will show up in the 1977 Chevy line. The most weight will be taken out of station wagons, where the clamshell tailgate will be replaced by a three-way door type. Weight reduction in other models results from shorter cars—Chevy has lopped up to 2 inches off its models.

Skinny glass

Chrysler will save 10 to 13 pounds per car by using thinner glass in the doors and quarter windows of its intermediate cars next year. The new glass is 18 percent thinner. It's reportedly just as strong and safe as the thicker glass because it has been treated by an improved tempering process.

Olds goes diesel

Oldsmobile is hard at work developing a V8 diesel for use in GM's luxury-car lines. The engine will be built on a 350-cu.-in. V8 engine block used in today's cars. But displacement will be cut to 280 cu. in. to allow designers to beef up the combustion chambers. First production is slated for Chevrolet trucks late in 1977. Olds has plans to use the new engine in some 1978 models, probably the 98 series. The diesel will be more durable, more economical to operate, and probably cost about the same as a standard gasoline version.

More lean, more clean

In 1977 Chrysler plans to extend the use of its Lean Burn combustion system to the 360-cu.-in. V8-engine line. This year the company builds only the 400 and 440 engines with Lean Burn.

Later, Chrysler will install the system in the 318-cu.-in. V8 and perhaps in the company's six-cylinder engines as well. But one advantage of the Lean Burn system will soon be lost. It will require a catalytic converter in order to meet the stricter 1977 emission standards. Up to now, Lean Burn has not had to use air pumps, converters, or a number of other add-on emission-control devices.

Super six

Chrysler has a more powerful version of its 225-cu.-in. slant six ready for 1977 introduction. The engine has a two-barrel carburetor instead of the one-barrel used on the present 225. It will be available on Charger, Monaco (Coronet), and Fury models as standard equipment, and as an option on Volare and Aspen. The engine is more economical to operate than a V8, burns less gas, and develops about 110 horsepower—10 percent more than the base 225 engine.

Little Lincoln

Code named "5700," the compact Lincoln is set for introduction next spring as a 1977½. The 5700 refers to the engine displacement in cubic centimeters. It's really 351-cu.-in., and basically the same engine Ford uses throughout its big-car line. The 5700 will have fuel injection, which will—besides matching the Cadillac Seville—make it smoother running, easier starting, more powerful, and more economical to operate.

Styling highlights of the car include a body and chassis lifted directly from Granada, with new front and rear ends. The grille is borrowed from the Mark IV; rectangular headlights set side-by-side provide a fresh look. At the rear, a fake spare-tire bulge in the deck lid carries out the Mark IV theme.

Ford's Chevette?

The new mini-compact Fiesta that Ford is preparing for 1977½ introduction looks a lot like Chevy's Chevette. It has a simple design, with short sloping hood, a rectangular grille opening between fender-mounted round headlights, and a hatch door at the rear. It displays its strongest resemblance to the Chevette from the side and rear.

Engineering differences between Fiesta and Chevette center around Ford's

front-drive power train. Front drive should give the new car an edge in high-speed stability, interior room, and traction on slick road surfaces. Slated for a 1.6 liter four-cylinder engine, the Fiesta should match Chevette's 40-plus-mpg fuel consumption, too

Checker checking

A study by the Checker Corp. shows that the life of a New York taxi can be as short as 18 months. It will build up only 75,000 to 80,000 very tough miles in that time. Checker, which builds about 5000 of the 50,000 cabs sold each year, found that cabs in other parts of the country, given correct maintenance and an easy driving schedule, can go as long as 10 years in regular service and accumulate 300,000 miles on the odometer.

Checker's unique body and chassis are essentially unchanged since they were introduced in 1958, and the company has no immediate plans to update the design. But diesel engines are a possibility. Checker is now running a fleet of Perkins diesels in cabs. The biggest problem is high purchase price, not performance.

Seeing spots?

If you look closely at side glass on cars, you're sure to notice cloudy spots that seem to be deep down in the glass. They become especially noticeable on sunny days when you're wearing polarizing glasses. The spots are stress patterns that occur when the glass is tempered at the factory. The glass is tempered in such a way that the outside surface and the edges are set in tension against the inside of the glass. The spots occur where jets of air are used to cool the glass after it is formed. More tension is set up closest to the jets and that's why it shows up as a different color. You won't see the spots on windshields, since that glass is not tempered; it depends on a laminated design for strength.

What is a big car?

GM officials claim that 1976 is not the last year for the big car. But they're playing with words. GM's 1977 big-car line will include models about the size of the present intermediates. But the new cars will be called "full-size" or "big." GM's view is that the new models will carry six passengers and luggage just like present big cars. So even if they are smaller on the outside and lighter in weight, they are still big-car types that can do all the jobs of today's full-size models. Aside from the words, though, the day of the full-size heavy-weight sedan is quickly coming to a close. It may reappear sometime in the future, but that seems unlikely, given the regulations on fuel economy planned in Washington. But that's not all bad. Think how easy it will be to park those smaller cars in spaces too small for the bigger models.

People write to



Have a question about motor oil? Lubricants? Engines? Ask the Pennzoil experts...

No Substitutes, Please. Since brake fluid has gotten so expensive, I was wondering if there is a substitute for it, such as transmission fluid.

B.O., Spartanburg, South Carolina

Definitely not! It's a specially compounded product and the use of anything other than brake fluid where it is recommended can result in serious consequences.



Addition Problem. If my motor oil is down half a quart, must I wait until the dipstick shows I'm a quart low, or can I add the quart and have the dipstick show half a quart over full? Is there any danger in overfilling the crankcase?

L.B., Alton, Iowa

You should never overfill your crankcase. It can result in any or all of the following: 1. Higher oil consumption, 2. Fouled spark plugs, 3. Deposits that cause pre-ignition (which can damage a piston), and 4. Foaming of the oil and collapse of hydraulic lifters (which can damage the entire valve train).

Multi-Vis Advantages. There is frequent discussion between owner, dealer and independent mechanic about the pros and cons of multi-weight vs. single viscosity oils. I'd like your recommendation, particularly for this region where winter temperatures vary from -35°F to $+60^{\circ}\text{F}$, and summer temperatures can get as high as 92°F .

D.L.G., Estes Park, Colorado

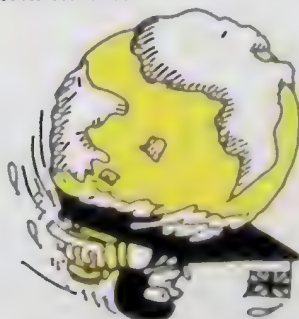
The main advantage of multi-viscosity oils is that they do not change viscosity as much as single grade oils with temperature changes. If temperatures are moderate with little daily or seasonal fluctuation, a single grade oil may be used. In your area with its wide temperature range, there are definite ad-

vantages in the use of multi-vis oils. At the temperatures you listed, we would recommend Pennzoil Multi-Vis 10W-40. It can be used on a year-round basis.

Pleased With Pennzoil. Our company has been using Pennzoil for about seven years and is very happy with the results. We've been using straight weight 30 oil in the '69 Chevrolet Impala and the '70 Olds 88 in the summer, and 10W in the winter. We also use the straight weight oil in a C-60 Chevy stake truck all year round using an engine heater to get it started in the winter. Any suggestions to better the oils we're using? Also, I just purchased a '75 Chevy Suburban; what oil viscosity would you recommend for it? It pulls a trailer much of the time. I am leaning toward using 20W-50 for the summer and 10W-40 for the winter. Do you agree with this? Again, thanks for a terrific product!

M.E.B., Mundelein, Illinois

It's always nice to hear from a satisfied customer. We can't suggest anything better than the maintenance procedure you are now using. Multi-grade oils do offer some additional convenience since the viscosity ranges extend over wider seasonal requirements. Should you decide to use multi-grade oil, Pennzoil with Z-7 SAE 20W-50 for summer and SAE 10W-40 for winter are excellent choices.



Boat Racing "Down Under". We use your Pennzoil Racing Oil (SAE 40) in our race boat fitted with a 454 ci Chevrolet motor, and would like to know how often you recommend the oil be changed.

J.T., Riverstone, N.S.W., Australia

Oil change frequencies of boat engines depend mainly on how the engine is op-

erated. Because yours is a race boat, you probably do very little idling and the engine would usually be run at full throttle. Under these conditions, the oil should be changed at a maximum of 100 hours, and perhaps less, depending on oil coolers and crankcase temperatures.

Funny Numbers. Does your 20W-50 4-Stroke Motorcycle Oil have enough viscosity for use in a Harley Sportster, especially in summer? Should I add some of your SAE 50 or 70 Aircraft Oil?

R.C.M., Chicago, Illinois

Your owners manual tells you to use 58W below freezing, 75W above freezing, and 105W for extremely hot temperatures and hard usage. These recommendations are quite confusing because they are not SAE grades, but Saybolt Universal Seconds. When converted into SAE grades they are as follows:

58W is SAE 20W-20

75W is SAE 40

105W is SAE 50

Pennzoil 4-Stroke 20W-50 Motorcycle Oil meets all requirements of Harley Davidson 58W through 105W. The addition of aircraft oil is not necessary.

WE'RE OPEN TO QUESTIONS about motor oils, lubricants, engines. But, you can tell us a few things, too. Maybe you have discovered something interesting about motor oils or lubricants. Or you have a special reason for being a Pennzoil fan. We would like to hear from you. Write to: Pennzoil Company, Research Department, P. O. Box 808, Oil City, Pennsylvania 16301. Note: sorry no pictures or material can be returned. Letters chosen for publication are subject to revision necessary for publication requirements.

Quality Products For Over 85 Years



ask for it!

Add insulation to your water heater



and subtract money from your fuel bill.*

That innocent-looking water heater may be the biggest waster of energy in your home. Good reason to install a Water Heater Insulation Kit. The vinyl-faced fiber glass insulation in this kit is designed for easy, do-it-yourself installation. Ask your insulation dealer for a Water Heater Insulation Kit II's new from Johns-Manville.



Johns-Manville

Box 5705 RP-PS1-Denver, CO 80217

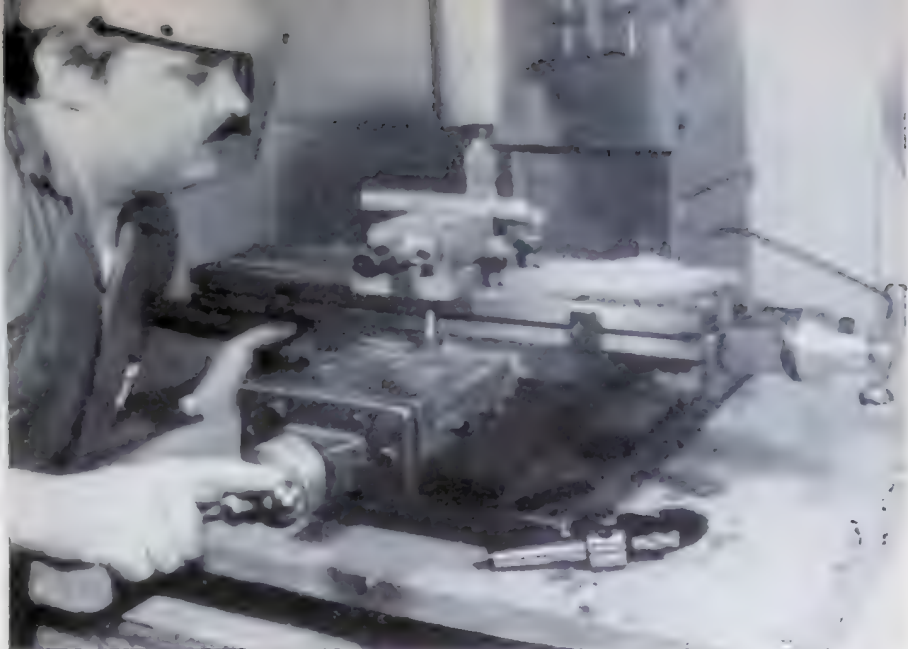
Please send me a copy of your folder about the Johns-Manville Water Heater Insulation Kit (HIG-497A)

Name _____

Address _____

City _____

County _____ State _____ Zip _____



Rugged home-shop vertical miller

A buyer's gap that has existed for a small, no-frills, fairly priced bench-top milling machine capable of serious work may now be filled with a new Twin brand Mini-Mill.

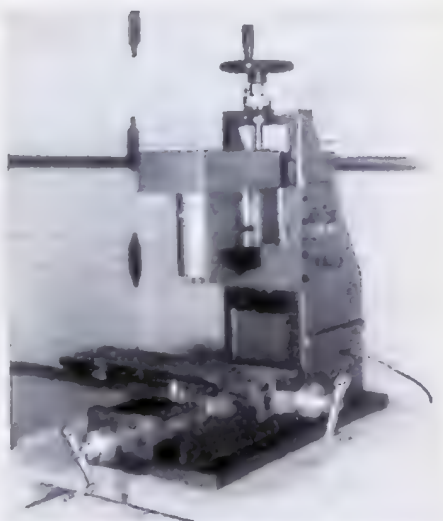
This vertical miller won't win any beauty contests, but it has plenty of brawn. With its heavy ribbed cast-iron base and unique H-frame column, it weighs about 320 pounds. It stands about 37" high and is 36" deep. The T-slotted work table is six by 20". Longitudinal travel of the table, via a large hand crank with an adjustable calibrated dial, is 10". Cross travel is six inches.

The hardened and ground spindle is bored for #2 Morse-taper-shank tooling and is mounted in tapered roller bearings. Tools are held in place with a draw bar.

The clever H-frame column makes the machine simple and solid, and eliminates the need for a quill and splined pulley. The spindle is fixed. The spindle housing, V-belt drive, and motor mounting are all one unit, which rides up and down on wide-spaced column ways. The gap in the ribbed column provides space for the belt to the motor, which is mounted vertically between the rear column flanges. The headstock can be fed up and down 10" for adjusting cut depth or boring.

The Mini-Mill is \$1099 with 1/2-hp motor (f.o.b. Houston, Tex.). It's made in England and sold in the U.S. by Caldwell Ind., Box 591, Luling, Tex. 78648. Optional equipment, such as machine vise, coolant pump, tool holders, and collets, is available.—Mack Philips

Impressive beef of Mini-Mill components is evident here. All ways have adjustable gibs; the table has feed stops.



Fixed spindle in unitized headstock-motor drive is unique. Handwheel at top feeds headstock up and down.



Belt guard hinges up for speed changes. Motor is mounted vertically behind column. Leadscrews are 3/4" diameter.

Where do the pros get their training?

Almost half of the successful TV servicemen have home study training, and among them, it's NRI 2 to 1! A national survey* performed by an independent research organization showed that pros named NRI most often as the recommended school and as the first choice by far among those who had taken home study courses from any school.

Why? NRI's 62-year record with over a million students . . . the solid training and value built into every NRI course . . . and the designed-for-learning equipment originated by NRI are part of the answer.

Training Geared for Success

NRI training is aimed at giving you a real shot at a better job or a business of your own. You learn at home, with "bite-size" lessons. "Power-On" kits, designed to give you practical bench experience, also become professional instruments you'll use in your work.

Includes 25" Diagonal Color TV and Quadraphonic Stereo

As a part of NRI's Master Course in TV/Audio Servicing, you build a 25" diagonal solid state color TV with console cabinet. As you build it, you perform "Power-On" experiments that demonstrate the action of the circuitry. And, you

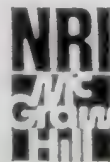


also build a 4-speaker Quadraphonic System! Instruments include a triggered sweep 5" oscilloscope, digital integrated circuit color TV pattern generator, a CMOS digital frequency counter, and NRI's electronics Discovery Lab. You get both TV and Audio training for hundreds of dollars less than the combined cost of courses at another school.

Free Catalog... No Salesman Will Call

Choose from the five different courses in TV/Audio servicing

. . . or you can learn Computer Technology with a real programmable digital computer; Citizens Band Radio; Communications; Aircraft or Marine Electronics; Mobile Radio, and more. Send the free postage paid card for our free catalog. See for yourself why the pros select NRI two to one! If card is missing, write to:



NRI SCHOOLS
McGraw-Hill Continuing Education Center
3939 Wisconsin Avenue
Washington, D.C. 20016

*Summary of survey results on request.

LOOK AND LISTEN

By WILLIAM J. HAWKINS



Programmable platter

Here's a turntable that's likely to turn the table on the industry—it's the new Accutrac 4000 from ADC and it's the first manual to actually think about what it's playing.

Naturally, it has the features you'd expect from most top-end models: direct drive, anti-skate, cue, and operational tracking below $\frac{3}{4}$ of a gram. But that's where similarities stop between Accutrac and other units.

The arm position of the Accutrac is electronically programmable—and by wireless remote control. Place a record on the platter and the Accutrac automatically plays each individual song in any order you choose.

The ultrasonic remote control, which duplicates the buttons on the player itself, has a button for any of 13 tracks, a play-all button, clear, play, begin, reject, cue, and even repeat, if you care to hear the same song again.

When you push a button, the tone-coded information is sent to the spherical receiver, which blinks an indicator to show it has received your command. The order in which you've selected the tracks is stored in a memory circuit

that's located inside the player.

When the *play* button is pushed, the arm swings up and out over the record. But inside the tone arm there's more than just a stylus—an infrared LED and a photo sensor are also there. The light from the LED shines on the record surface as the arm passes over. On a cut section of the record, the light is dispersed and not reflected back into the sensor cell (see inset drawing). Over the shiny blank grooves between each song, however, the light is reflected and the sensor tells that to the control electronics.

The control then counts the number of blank grooves as the arm passes over the record and compares it with the track order you've chosen. When they match, the arm lowers and begins to play the cut. At the end of the song the empty grooves are again sensed; the arm is lifted and begins the search for the next selection. Up to 24 commands on track order can be held in the memory at one time.

Accutrac 4000 is \$499.95, including cartridge, base, and dust cover. It's made by Audio Dynamics Corporation, Pickett District Rd., New Milford Conn. 06776.

Quick looks

- Big-screen TV need not be a projection system, according to Sony, who's just introduced a 32-inch TV set. It will cost you \$5000 plus the fare to Japan, however.

- CB walkie-talkies are in for a drastic change in the near future. After Mar. 18, 1977, it will be illegal to make them for use with the present CB frequency allocation. A year after that, makers won't be permitted to sell such units on hand to dealers. And after Mar. 18, 1983, it will be illegal to use them. A new band—at 49 mHz—will be allotted for the hand-held units.

- The FCC has been asked often to go out on a limb for one thing or another, but now it's been asked by the National Cable Television Assoc. to try a pole. Telephone poles, says the NCTA, are getting too costly to rent. The companies claim their cables are not the only things being held up and they want rental regulations enforced.

- Zenith has put its electronics expertise into a new display—no, not TV: a new digital watch. It has analog hands, but digital date and seconds display. Starts at \$195.

- RTS stands for Rapid Transmission and Storage, according to its inventor, Dr. P. C. Goldmark. This box allows audio and video information to be sent to remote recorders over cable or air at very high speeds—to be played back in real time at your convenience.

- Hitachi is expected to introduce a new amplifier shortly with a class E output. What it means to us hi-fi fans is 50 percent less heat, weight, and energy consumption, compared with an amp of equal wattage.

- A new image-conversion kit from Advent changes its VideoBeam projector to produce a six-by-eight-foot TV picture (normally it's about four by six) and on a standard glass-beaded screen from 140 inches away. The snap-on lenses will go for \$150.

- FCC commissioner James Quello found a way to eliminate the intolerable hash on the CB band—he had the rig mounted in his assistant's car. His assistant found a better way—it was stolen shortly afterwards.

- TV makers usually have a carry-in clause in their service contracts for portables—if it's portable, you carry your set into the repair shop if something goes wrong. That's understandable, but questionable when that "portable" weighs 60 pounds or more. According to the HEW publication, "Consumer News" the FTC is now awaiting a report from the National Bureau of Standards on exactly what portable means, considering the average strength and size of most Americans.

A P S P.S.

Got a valuable but a mechanically or audibly defective cassette? Send it—along with \$5—to Cassette Hospital, Box 30040, St. Paul, Minn. 55175, and you'll get back an electronically perfected copy in a new case.

Pioneer has conquered the one big problem of high-priced turntables.

The high price.

The best way to judge the new Pioneer PL-510 turntable is to pretend it costs about \$100 more. Then see for yourself if it's worth that kind of money.

First, note the precision-machined look and feel of the PL-510.

The massive, die-cast, aluminum alloy platter gives an immediate impression of quality. The strobe marks on the rim tell you that you don't have to worry about perfect accuracy of speed at either 33 $\frac{1}{3}$ or 45 RPM.

The S-shaped tone arm is made like a scientific instrument and seems to have practically no mass when you lift it off the arm rest. The controls are a sensuous delight to touch and are functionally grouped for one-handed operation.

But the most expensive feature of the PL-510 is hidden under the platter. Direct drive. With a brushless DC servo-controlled motor. The same as in the costliest turntables.

That's why the rumble level is down to -60 dB by the super-stringent JIS standard. And that's why the wow and flutter remain below 0.03%. You can't get performance like that with idler drive or even belt drive. The PL-510 is truly the inaudible component a



turntable should be.

Vibrations are damped out by the PL-510's double-floating suspension. The base floats on rubber insulators inside the four feet. And the turntable chassis floats on springs suspended from the top panel of the base. Stylus hopping and tone arm skittering become virtually impossible.

But if all this won't persuade you to buy a high-priced turntable, even without the high price, Pioneer has three other new models for even less.

The PL-117D for under \$175*. The PL-115D for under \$125*. And the amazing PL-112D for under \$100*.

None of these has a rumble level above -50 dB (JIS). None of them has more wow and flutter than 0.07%.

So it seems that Pioneer has also conquered the one big problem of low-priced turntables.

The low performance.

U.S. Pioneer Electronics Corp., 75 Oxford Drive, Moonachie, New Jersey 07074.

PIONEER

Anyone can hear the difference.

*For informational purposes only. The actual resale prices will be set by the individual Pioneer dealer at his option.

© U.S. PIONEER ELECTRONICS CORP.

It's about time.

tubeless tires for motorcycles



Tubeless tire costs just slightly more than would a conventional tire and tube

together. Spokeless rims, though, are much more expensive than spoked rims.



Conventional spoked rim lacks advantages of more rigid cast rim, which doesn't lose shape, and has no spoke holes for air to rush out if a flat occurs.



You can't see it, but first ply has sheet of gum rubber that acts as inner tube; it tends to grip any object that punctures tire, reducing rate of air loss.

By RAY HILL

If you ride a motorcycle long enough, sooner or later you'll have a flat tire. I've had a half dozen or so since I've been riding. The most recent was on a road race course in Virginia. I was leaving a curve at about 60 mph when I noticed an almost imperceptible wiggle. A split second later that tiny wiggle exploded into a vicious fishtailing slide that I barely managed to control. It was scary on the race track. It would have been even scarier on the highway, surrounded by cars going in both directions.

Fortunately, Goodyear has decided to make things less scary for us motorcyclists by introducing a tubeless tire. It has a lot going for it.

Safer and sturdier

- It's safer, because it doesn't lose air so quickly. When the tube in a conventional tire is punctured, air rushes out not only through the puncture hole, but through the spoke holes in the motorcycle wheel. The tubeless tire is mounted in a nonporous cast wheel, so the rate of air loss is reduced, allowing safer, more controlled stops.

- Without a tube, unsprung weight is reduced by two or three pounds (the weight of the tube) for each wheel. That improves handling.

- The solid cast wheels used for tubeless tires are sturdier than spoked wheels and do not lose their shape as spoked wheels do. This also contributes to safer and better handling.

- A tubeless tire runs cooler, because there's no friction between inner tube and tire. That makes for longer tire life.

- Tire changes are easier because you don't have a tube to remove and stuff back in. Anybody who's ever had to change a motorcycle tire can appreciate that.

The new spokeless rims

The technology to make a tubeless motorcycle tire has actually been around a long time. What hasn't existed is a suitable rim. Recently, three makers of motorcycle rims—Morris, Lester, and Shelby—have introduced spokeless rims that will accept a tubeless tire.

Biggest drawback in converting to tubeless tires is the cost, not of the tires, but of the solid rims they must be mounted on: They take a bigger bite out of your wallet. Still, a parachute is expensive, too; but it's nice to have one when you need it. **42**



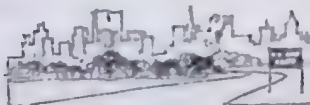
You'll like the price and mileage. You'll also like the car.

Prices start at \$2899*
2-Seat Scooter \$2899*
The Coupe (shown) \$3098*

*Manufacturer's Suggested Retail Price including dealer preparation. Tax, license, destination charge and available equipment additional.

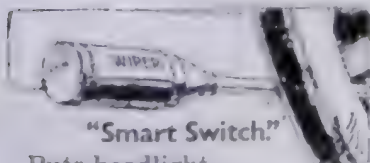


40 MPG HIGHWAY



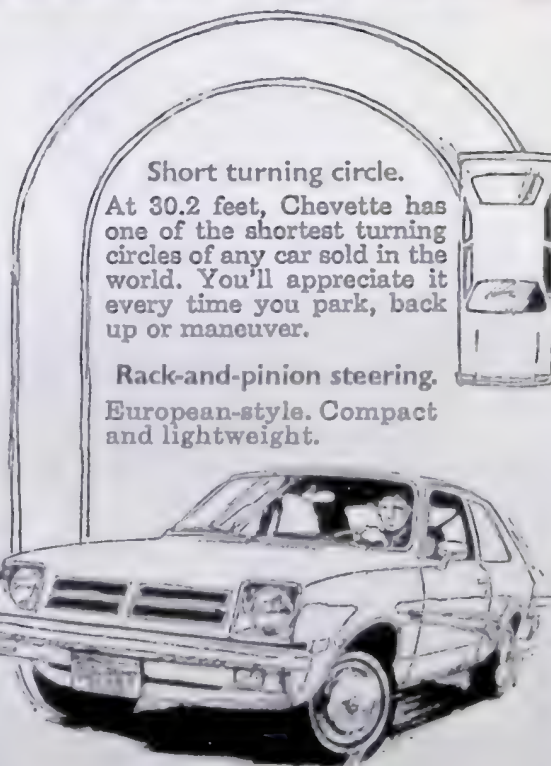
28 MPG CITY

EPA mileage with standard 1.4-litre engine, 4-speed manual transmission and standard 3.70:1 rear axle. (Remember—these mileage figures are estimates. The actual mileage you get will vary depending on the type of driving you do, your driving habits, your car's condition and available equipment. In California, see your Chevy dealer for EPA mileage figures on California emission-equipped cars.)



"Smart Switch."

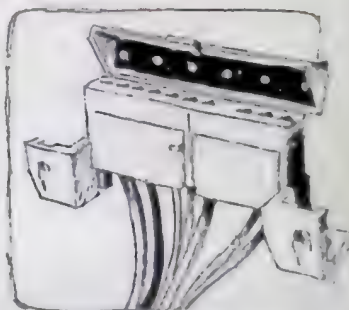
Puts headlight dimmer, turn signal, windshield washers, windshield wipers and lane-change signal all at your fingertip.



Short turning circle.

At 30.2 feet, Chevette has one of the shortest turning circles of any car sold in the world. You'll appreciate it every time you park, back up or maneuver.

Rack-and-pinion steering.
European-style. Compact and lightweight.



Diagnostic connector.

Lets you diagnose primary ignition circuit and other parts of the electrical system.



Freedom battery.

Freedom from worry about adding water or checking water levels. Sealed side terminals resist corrosion buildup.



6,030 dealers

That's nearly twice as many as VW, Toyota and Datsun combined. Parts and service are always nearby.

Chevette

CHEVROLET'S NEW KIND OF AMERICAN CAR.



Room for four.

With space for luggage behind the back seat. Seat folds down for expanded load space, accessible through rear hatch.

For on or off the road: **4WD** **trailbreakers**



PS ratings—test report in a nutshell

The ratings are based on test results and measurements. Results should be read with the understanding that they reflect tests only on our sample cars, and that other seemingly identical cars may vary in performance. Also, weather conditions (noted in our spec table) vary from test period to test period. An excellent rating is 5 points; very good is 4; good, 3; fair, 2; poor, 1; very poor, 0.

	Scout	Jeep	Subaru
Fuel economy	2	1	4
Acceleration	0	5	0
Braking	3	4	4
Handling	0	0	0
Maneuverability	2	3	3
Ride comfort	1	0	1
Quietness	0	1	1
Roominess	4	3	3
Visibility	2	5	5
Entry/exit ease	5	5	2

By JIM DUNNE and RAY HILL

The field of four-wheel-drive vehicles got some unusual entries in the past 12 months. Three distinctively different models made their debuts: a diesel-powered Scout, a more comfortable version of the Jeep, and a sedan-like Subaru station wagon.

Though all three have four-wheel-drive systems capable of just about anything you can ask for in off-road mobility, they are very different types and cannot be compared with each other. Here's a rundown on the most notable features of each.

International Scout Traveler

Latest version of the Interna-

tional Scout line, the new vehicle is bigger and huskier. But the major difference is a 198-cu.-in., six-cylinder diesel engine. Coupled with a standard four-speed manual transmission, the drive train provides strong lugging power. The engine is a standard diesel design, and that means ruggedness and long life.

But a diesel, while strong, doesn't work best at high speed. That's one reason why the acceleration times we recorded are relatively slow. The 0-60-mph time of 29 seconds is poor. On the other hand, sparkling acceleration is not a top priority for an off-road vehicle. Dependability and low-speed power count more. And that's where the Scout diesel does its best.

Fuel economy is a big and pleasant surprise. While the Scout's 17-mpg city and 23-mpg highway results may not seem impressive compared with passenger-car figures, they are excellent for a 4000-pound class vehicle of the Scout type. And they glow when matched

Continued

Three 4WD test vehicles are put through their paces over rugged terrain in the Bridgehampton Race Circuit area. From top to bottom: Subaru, International Scout, and Jeep CJ-7. They may point to 4WD's future direction: more interior room and plushness, along with off-road capabilities.

Try this Shell "Fact or Myth" Quiz.

The right answers could save you some money on your next oil change.

Which is fact and which is myth? If you don't know you could be overspending when you change your oil.

Fact or Myth?

Motor oil must be changed when it looks dirty

Myth. Just because your oil looks dirty doesn't mean it's dirty enough to require changing. High-detergent motor oils like Shell Super X* 10W-50 motor oil, Shell X-100* Multigrade, and Shell X-100* can suspend about a pound of engine dirt and contamination before they need changing.

So don't rely on the appearance of the oil. Stick to the oil change schedule in your owner's manual. Don't change more often—or less often—than recommended there.

Fact or Myth?

Motor oils made from Pennsylvania crude oil necessarily perform better

Myth. Where oil comes from has very little to do with the quality of the finished product. The key things that make one motor oil better than another are how well it's refined, and the additives that go into it. Those are the things that make Shell's high-detergent motor oils good enough to meet and exceed all U.S. car makers' tough requirements.

One way to tell if the oil you're using meets your engine's requirements is to look for Service Classification "SE" on the can. You'll find an "SE" on every can of Shell Super X 10W-50 motor oil, Shell X-100 Multigrade, and Shell X-100.

Fact or Myth?

When choosing a motor oil, you should consider the way you drive

Fact. How and where you drive determines how hard an oil will have to work.



The Shell Answer Man helps you choose the right motor oil for your car.

If you do a lot of heavy-duty driving, like stop-and-go or trailer towing, try Shell Super X. Its 10W-50 rating is the widest multigrade range you can buy. That means high-temperature protection plus low-temperature startability.

If you drive in all kinds of weather, Shell X-100 Multigrade could be right for you. With it, there's never a need to change oil with the seasons.

If you drive in weather that's fairly consistent from season to season, maybe all you need is a good single grade motor oil like Shell X-100. It's available in SAE 10W, 20W-20, 30 and 40 grades.

Look for Shell motor oils at Shell service stations or wherever fine motor oils are sold.

If you would like more information on motor oil, write for the free booklet, "Questions and Answers About Motor Oil." Shell Oil Company, P.O. Box 61609, Civic Center Station, Houston, Texas 77208.



**Come to
Shell for answers**



Subaru wagon negotiates PS maneuverability course. This low-speed course simulates crowded city conditions where low-speed maneuverability is important.

Fuel mileage (mpg)

	Scout	Jeep	Subaru
Highway	23.0	15.2	33.0
City	17.0	12.4	22.0
EPA test (city)	None*	12.0	29.0
(California)	None*	(V8 n.a.)	24.0

*Exceeds EPA load weight limit for vehicle test requirements

against the eight-13 mpg that we recorded for gasoline-powered vehicles that compete with Scout in the utility field (PS, June '74). Also, the diesel gives a 100-percent improvement in highway fuel economy over the Scout gasoline-engine V8 we tested back in July, 1973.

The price of diesel fuel is currently running about five cents a gallon less than gasoline, which should mean an additional 10-percent reduction in fuel cost.

Compared with a gas engine, the Scout diesel is slow to start. When the engine is cold, you turn the key on and push the glow-plug button for 15 or 20 seconds until an indicator light goes on. You

then start it like a gas engine. To stop the engine, you turn off the key, then pull an engine-stop knob on the instrument panel. To restart once the engine is warm, you simply turn the key.

The Scout can run in two- or four-wheel drive. To shift into four-wheel drive, just pull a lever on the instrument panel. The system must be disengaged—push in on the knob—when you're driving on dry pavement.

The new body design is a departure from that used on earlier Scout models. The hatch door at the rear opens wide for easy loading of large items. Two gas-filled tubes help lift and lower the hatch. The truck-type side doors have a passenger-car finish on the inside and help make the interior one of the most civilized in the 4WD field. Carpeted floors, bucket seats, and lots of passenger room are other comfort features.

Jeep CJ-7 Renegade

A new model this year, the CJ-7 has a wheelbase 10 inches longer than that of the CJ-5, AMC's base Jeep vehicle. From that change come a number of upgrading differences. The CJ-7 has a better ride, more room inside, a new suspension, more cargo space, and larger door openings. In addition, some minor appearance changes set the CJ-7 distinctly apart from the CJ-5.

But the biggest changes are in the drive train. The CJ-7 offers automatic transmission as an option, and now Quadra-Trac full-time four-wheel drive can also be ordered.

The plastic upper body and steel doors are great improvements. However, door fits and body tightness are still not up to the quality of other 4WD models.

Old-time Jeep owners will be sur-

prised by the luxury touches: The floors are fully carpeted, the steering wheel has a cushioned feel to it, and attractive Levi material covers the seats. A full complement of gauges is part of the package. To improve access to the rear seat, the front passenger seat pivots forward, leaving a wide step space to move through.

But efforts to upgrade the interior fall short in some respects: Webbed straps are used for door checks, detracting from the appearance; a primitive door-lock mechanism is fully exposed on the inside of the door. We also disliked the location of the gauges. They're at knee level—difficult to read, especially on rough roadways. The window frames in the doors are highly flexible, and that can cause pronounced air leaks around the top edges when the car is moving at speed. The resultant loss of heat in the wintertime and the increase in noise levels are serious comfort drawbacks.

While front-seat room is excellent, the rear seat, despite the improvement over the base Jeep, is almost cramped. It's not a place you'd want to spend any amount of riding time. The rear wheel wells form shelves beside the seat and act as unyielding elbow rests for rear passengers. The seat does not fold forward, so, to use extra storage space in the back, it's necessary to unbolt the whole seat and take it out of the car.

Another serious problem is the height of the body panel at the base of the door. This panel rises 6½ inches above the front floor, one of the highest you'll ever encounter, and can be a real ankle-bruise when you enter or leave the front seats.

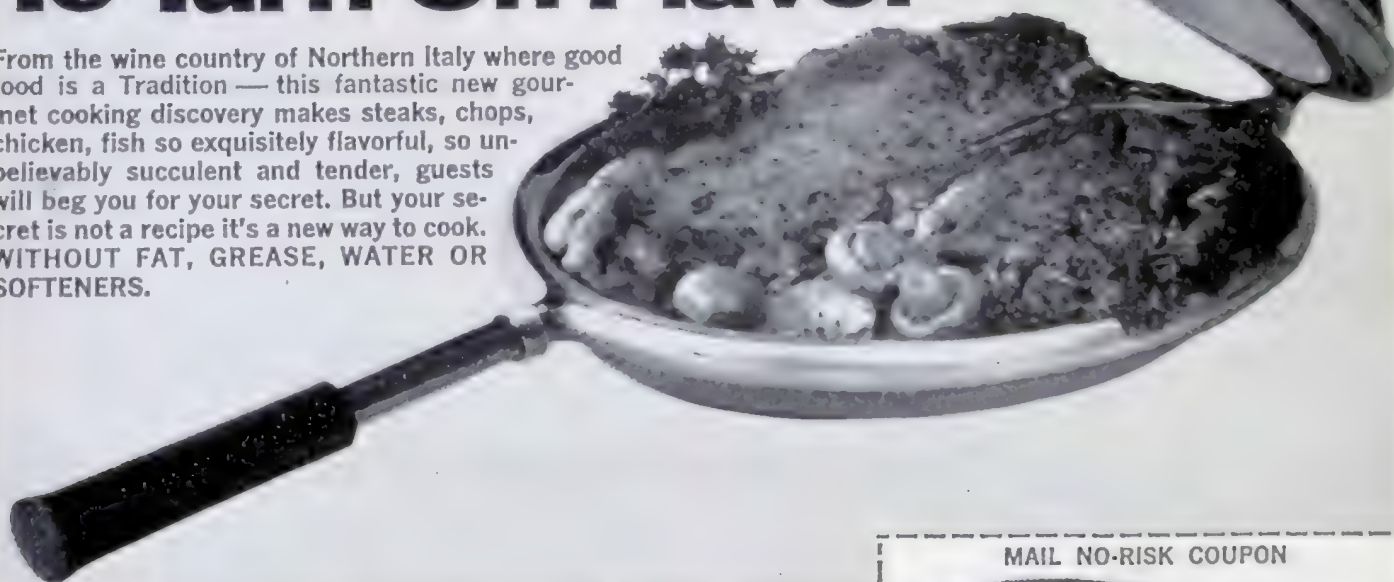
A big surprise is the performance of a V8-powered Jeep. The acceleration

Continued

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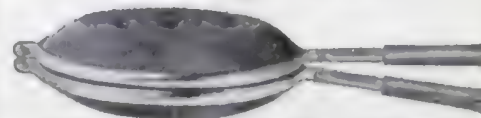
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In PS braking test, one cold and one hot stop is made from 60 mph, with 10

warmup stops from 1/2 g made in between. Here, Scout stops in 157 feet.

tion—0 to 60 in less than 11 seconds—makes it quicker than most sedans sold today. It is one of the fastest 4WD vehicles ever tested by PS. Buyers should look at a Jeep equipped with the 258-cu.-in. six-cylinder engine first. It has good power, and the advantage of slightly better fuel economy.

Fuel-economy figures for the CJ-7 are disappointing compared with those of the Subaru or Traveler. But they are not out of line with the economy of other gasoline-powered American 4WD vehicles.

The most serious fault we found with the CJ-7 was handling. Body roll is excessive in turns, due in part to the very quick power-steering ratios, and in part to the lack of control in the suspension. Pull the wheel to one side, and the re-

action is immediate, and slightly scary for our tastes. In our handling tests, the inside rear wheel lifted off the pavement in both right- and left-turn maneuvers—an indication of instability, and a cause of serious concern for any driver.

The new design of the CJ-7 allows Jeep to offer full-time 4WD for the first time in its smaller vehicles. The full-time system runs on dry pavement with all four wheels providing traction. If the going gets really sticky, you can lock up the drive—make all four wheels pull with full power—by simply turning a control knob inside the glove box.

Subaru

A unique vehicle that could change a lot of minds about the conveniences of 4WD, it looks like the standard Subaru front-drive wagon but has all the benefits of full-traction, off-road vehicles that cost much more. Inside, it looks like an ordinary sedan except for the shift lever for the 4WD transfer case. A minimum of gauges is offered, and they are grouped directly in front of the driver.

The rear seat folds forward to form a long, flat floor that presents a highly usable loading surface. Locked upright, it provides only a minimum of passenger space that most adults would find cramped and tiresome.

Biggest problem with this car centers around a lack of lugging and accelerating power. The comparatively tiny 84-cu.-in. four-cylinder engine is just right for a small economy car, but it lacks the reserves needed in some off-road driving situations. Acceleration times are slow—though not nearly so slow as those of the Scout diesel.

The engine is equipped with the Subaru Exhaust Emission Control Technique (SEEC-T), which requires no catalyst or other tack-on

emission-control device. Briefly, SEEC-T is a system for introducing fresh air into the combustion chamber that works with the air/fuel mixture to sandwich unburned exhaust and insure more complete burning. Besides cleaning up the exhaust, the system allows the engine to burn a leaner mixture of fuel, and that means better economy. The Subaru 4WD wagon delivers fuel economy greater than anything considered possible in this type of vehicle just two years ago. Our tests show 33 mpg on the highway and 22 mpg in city driving—a remarkable achievement.

Noise levels inside the car are not up to sedan standards. We think a combination of factors work against Subaru here. The open rear compartment of the wagon plus the dual drive system create a noise problem that is difficult to overcome at low speeds. At highway speeds, though, the Subaru is markedly quieter than either Jeep or Scout.

Subaru also gets top marks for the easiest-working four-wheel-drive shift lever. Little more than a wand, it moves two inches up or down to shift from one drive system to the other. And you can shift in and out of all-wheel drive while the car is moving. It's one of the simplest we've ever encountered.

Maintenance

• *International.* The biggest maintenance difference between the diesel engine in this vehicle and a conventional gasoline engine is in the tuneup area. Because the typical person lacks the equipment or knowledge to tune a diesel, that job must be done at a garage.

Other maintenance chores, though, can be easily performed. There are no obstructions to checking any of the fluid levels. Oil changes are easy: The oil filter can be removed from top or bottom, and the oil fill is easily accessible on top. Radiator and heater hoses are easy to disconnect at both ends.

Unlike the Subaru and CJ-7, which have no grease fittings, the International has them—in our opinion, an asset in an off-road vehicle.

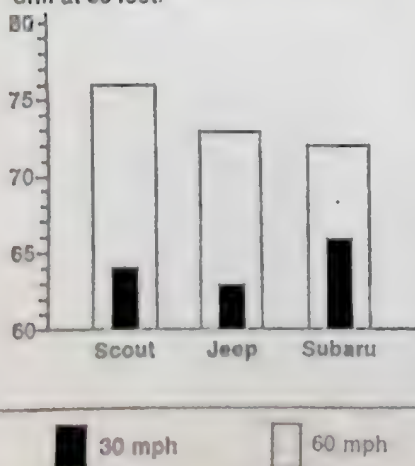
Changing coolant or shocks, and doing other normal maintenance work present no extraordinary problems. The fusebox, though, under the left side of the dash, is a real pain to get at.

[Continued on page 108]

For specs and test results, turn page

NOISE-LEVEL TESTS

Interior noise is measured in decibels on the A scale on our standard General Radio sound-level meter applied under three sets of conditions. A reading of 50-dBA is like an average residence. A 60-dBA reading is like a large store; 70-dBA, like a freight train going by 100 feet away; 80-dBA, like a pneumatic drill at 50 feet.



Volare



The accent is on comfort.

We've created a new kind of small car. One that's truly comfortable. By engineering comfort into Volare where comfort starts—in the suspension system.

Comfort that's built in, not added on.

The new system built into Volare is called an Isolated Transverse Suspension (pat. pend.); an innovation in small car engineering.

It actually gives the small Volare a smooth, comfortable ride like a big car.

We've made the comforting ride of Volare even more enjoyable by giving you a broad expanse of glass, and a special noise-reducing system for quietness.

Big car ride, small car gas mileage.

The Volare is very easy on gas. According to E.P.A. estimated



mileage results, of all Volares, the wagon did best—30 mpg on the highway, 18 in the city—equipped with 6-cylinder engine and manual transmission. Your actual mileage may differ depending on how and where you drive, the condition of your car and optional equipment.*

And, here's "The Clincher:"

For the first 12 months of use any Chrysler Corporation dealer will fix, without charge for parts and labor, any part of our 1976 passenger cars we supply (except tires) which proves

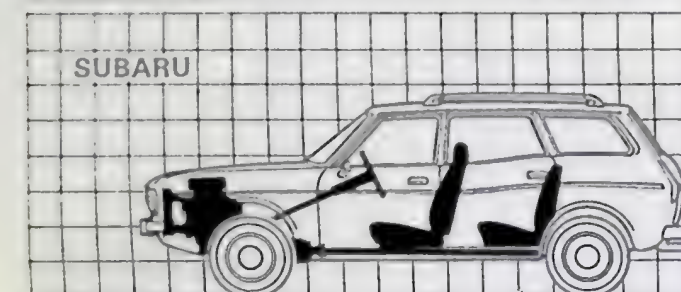
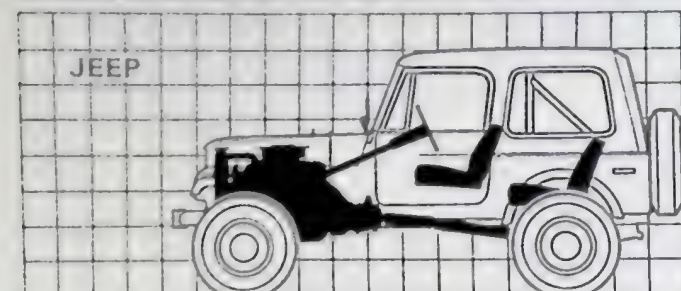
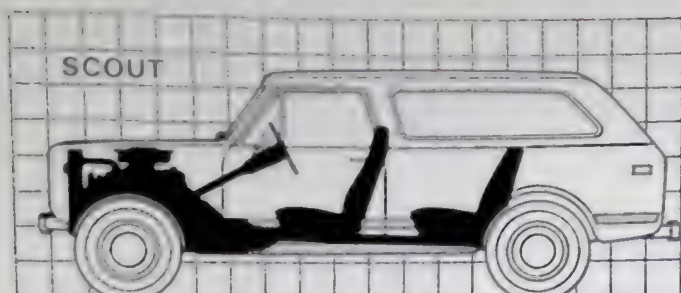
defective in normal use. Re- of mileage.

The owner is responsible maintenance services such as changing filters and wiper b

And the regardless of mi part is especially nice. Bec economical Volare is one c going to love to drive

The new small from Plymouth

*In California, see your dealer for engine availability and mileage data for California equipped vehicles.



All three vehicles have four-wheel-drive systems capable of handling most off-road conditions, but each is distinctive. Subaru is a small utility station wagon that delivers uncommon mileage for a utility vehicle. Scout's appeal lies in its rugged diesel engine and spacious, comfortable interior. CJ-7 offers all the power you can ask for with its big V8 engine, plus an automatic transmission and more acceleration than most passenger sedans can muster today.

Performance comparison with selected 1973, 1974, and 1976 models

	Mpg (city driving)	Accel. 0-60 mph (sec.)	Brakes 60-0 mph (ft.)	Handling (mph)	Maneuver. (mph)	Noise @ 60 mph (dBA)
1974 Chevrolet Blazer L6	11.4	25.8	163.0	58.2	23.9	73
1974 Plymouth Trailduster V8	9.0	12.1	194.0	47.2	23.0	74
1974 Dodge Ramcharger V8	10.6	16.4	176.0	47.2	23.0	77
1974 Jeep Cherokee V8	10.7	15.6	172.0	56.3	25.3	73
1973 Ford Bronco V8	11.1	15.0	179.5	53.0	25.7	77
1973 International Scout V8	11.8	16.4	195.0	60.0	24.0	74
1976 VW Rabbit L4	24.0	13.5	115.0	63.0	30.0	72
1976 Plymouth Volare V8	13.0	14.9	177.0	56.3	25.0	66
1976 Chevrolet Nova L6	14.0	16.0	140.0	64.7	26.4	67
1976 Ford Granada L6	11.0	23.2	183.0	60.0	25.7	72

Scout, Jeep, and Subaru—specs, dimensions, and test results

	INTER-NATIONAL SCOUT	AMC JEEP RENEGADE	SUBARU WAGON
DIMENSIONS (inches)			
Ground clearance	8.0	6.9	8.0
Front leg room (max.)	45.0	44.0	42.7
Front head room	38.0	37.0	36.5
Rear head room	36.0	38.0	35.0
Rear leg room (min.)	39.5	37.0	32.2
Front hip room	41.0	36.0	43.0
Rear hip room	48.0	34.0	47.0
Couple distance	36.0	33.0	26.5
Min. rear knee room	7.0	4.5	2.5
Wheelbase	118.0	93.5	96.1
Overall height	66.0	70.5	57.5
Overall width	70.0	59.9	59.1
Overall length	183.8	147.9	158.7
Front track	57.1	51.5	49.4
Rear track	57.1	50.0	47.4
SPECIFICATIONS			
Engine type	6-cylinder in-line	V8	4-cylinder, 2 opposed
Displacement (cu. in./cc)	198/3245	304/4983	84/1361
Compression ratio	22:1	8.4:1	8.5:1
Carburetion	Fuel injection	2 bbl.	2 bbl.
Net hp @ rpm	92 @ 4000	120 @ 3200	56 @ 5200
Net torque @ rpm	140 @ 1700	220 @ 2200	67 @ 2400
Transmission	4-speed manual	3-speed automatic	4-speed manual
Axle ratio	3.54:1	3.54:1	4.125:1
Tire make	General	Goodyear	Bridgestone
Tire type	Radial dual	Suburbanite XG	RD 701 mud & snow radial
Tire size	HR78x15	Polyglas H78x15	155SR13
Steering	Recirculating ball power assist.	Recirculating ball power assist.	Rack-and-pinion manual
Overall steering ratio	24:1	17.5:1	19.2:1
Turns lock to lock	4.25	4.25	3.25
Turn diameter (ft.)	38.8	35.8	37.6
Front suspension	Semi-elliptical leaf springs, solid axle, hypoid gear	Full floating, leaf springs, solid axle	MacPherson strut type, independent coil springs
Rear suspension	Semi-elliptical leaf springs, solid axle, hypoid gear	Full floating, leaf spring, solid axle	Semi-trailing arm, independent torsion bars
Front stabilizer-bar diameter (in.)	1.1	N/A	0.79
Rear stabilizer-bar diameter (in.)	None	None	None
Emission-control equipment	Diesel fuel, fuel injection	Catalyst	SEEC-T*
Loading-area average (in.)			
Length	52.0	27.0	33.0
Width	54.0	36.0	41.5
Height	38.0	15.0	31.0
Liftover	26.0	28.0	22.5
Trailer-towing capacity	5000 lb.	5000 lb. w/750 lb. tongue load max.	500 lb. w/50 lb. tongue load max.
Brakes	Power Disk/drum	Manual Drum/drum	Power Disk/drum
Brake type	327.0	276.0	211.3
Brake swept area (sq. in.)	19.0	15.5	11.9
Fuel tank (gal.)	Behind rear seat: 62.0	Behind rear seat: 8.4	33.6**
Trunk space (cu. ft.)	26.0	28.0	22.5
Liftover height (in.)	3956	2800	2190
Curb weight (lb.)	5446	5545	5842
F/R weight distribution (%)	\$7537	\$4299	\$4149
Basic price	\$8492	\$6813	\$4250
Price as tested			
TEST RESULTS			
Acceleration 0-60 mph (sec.)	29.0	10.6	24.5
Acceleration 0-80 mph (sec.)	N/A	22.2	N/A
Acceleration 25-70 mph (sec.)	44.0	12.9	30.5
Brake test (cool)			
Stopping distance (ft.)	127.0	141.0	129.0
Pedal pressure (lb.)	160.0	110.0	70.0
Efficiency (% of 1 g)	90.0	100.0	87.0
Disk temperature (F)	124	75	172
Brake test (hot)			
Stopping distance (ft.)	157.0	127.0	136.0
Pedal pressure (lb.)	120.0	140.0	120.0
Efficiency (% of 1 g)	83.0	95.0	100.0
Disk temperature (F)	533	267	303
Interior noise @ 60 mph	76 dBA	73 dBA	72 dBA
Handling test (mph)	49.9	51.3	51.3
Maneuverability (mph)	24.6	25.7	25.0

TEST CONDITIONS: Ambient temperature 58 F, relative humidity 42 percent, barometric pressure 29.8 inches.

*Subaru exhaust emission control technique
**54 cu. ft. w/rear seat folded down

Why should you spend \$3.95 for a can of motor oil?



Introducing Mobil 1
synthesized engine lubricant.
It's better than conventional oil,
no matter how you drive.

It's a whole new lubrication generation: A unique multiviscosity fluid made with synthesized hydrocarbons from a patented Mobil process.

It can work magic for your engine. Here are seven reasons why.

Better engine protection.

Mobil 1 protects valve trains, gears, piston rings and cylinders better than ordinary oils. It's a performance reserve you can count on.

To prove it, we put Mobil 1 in a fleet of highway patrol cars for 12,000 miles. Then, we tested that used" oil against conventional motor oil in a Pinto engine at 3000 rpm for 150 hours. Even after all its previous use, Mobil 1 protected like brand-new ordinary oil.

© 1976 Mobil Oil Corporation.

Better high-temperature performance.

If you drive fast and hard, you'll find Mobil 1 won't thicken and form deposits to the extent ordinary oil does.

We proved it in the Olds IIIC "SE" high-temperature-high-load test (3000 rpm, 100 HP, 300° F oil). Ordinary oils are tested for only 64 hours. But we had to double the test length to get even a significant viscosity increase with Mobil 1.

Faster cold starts.

Down where even antifreeze turns to mush, Mobil 1 helps your engine start quickly. Ordinary oils are so thick at -20° F we can't measure their viscosity. Mobil 1 still flows at -50° F.

Cleaner intake system.

Because it's so stable, Mobil 1 forms less deposits on intake area and valves. In a cyclic test on a 6-cylinder, 250-cu.-in. Chevy engine, Mobil 1 gave 78% less buildup on intake valves than conventional oil, after 200 hours of testing.

Less oil consumption.

Mobil 1 isn't used up as fast as ordinary oils. (Providing your engine is in good mechanical condition.) In city and highway fleet tests, Mobil 1 cut oil consumption by as much as 25%. This means a cleaner exhaust stream.

A cleaner engine.

A lot of people say it. We can prove it. Our exclusive detergent additive package is why. Even after 384 hours—double the standard length—in the Ford VC test, Mobil 1 came up better than ordinary oil standards in every way. Less sludge and varnish. No oil ring or screen clogging. No ring sticking.

Better mileage.

You can get more miles per gallon, too. Up to 10 miles per tankful for the average car. Sure, you know a million ways to boost your mileage; here's a way to get a little bit more.

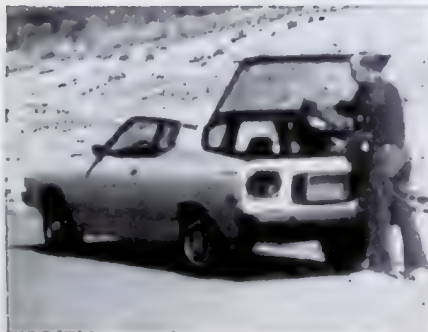
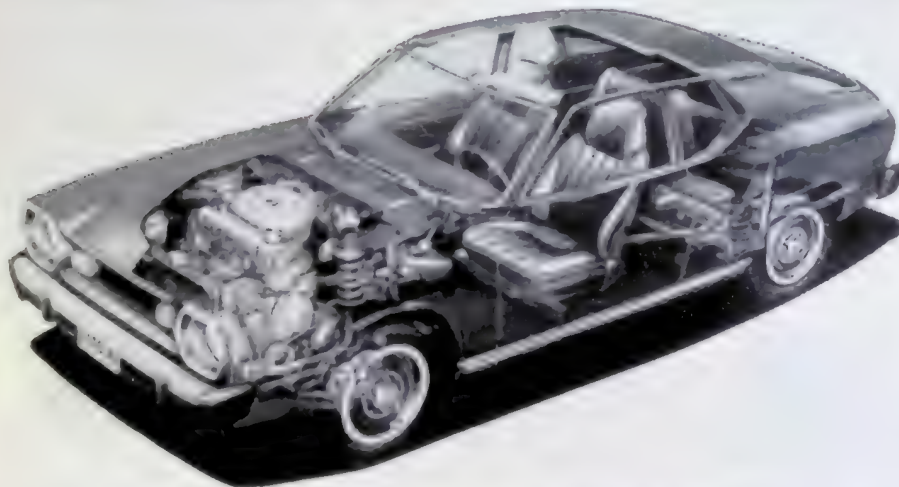
That's the Mobil 1 story. And now you know why it's worth up to \$3.95. Or even more.

Mobil 1

The oil that saves you gas.

By JIM DUNNE

New Datsun F-10, FWD and high mpg



Transversely mounted engine is shown in cutaway drawing, top. Station-wagon and hatchback versions are available. Both feature high liftover, making loading and unloading baggage an extra effort, as author Dunne discovers in photo at center right. Spare wheel is stowed beneath the trunk floor.

Specifications

Datsun F-10

Overall length	155.5"
Overall width	59.8"
Overall height, coupe	51.8"
Overall height, wagon	53.7"
Wheelbase	94.3"
Front track	50.4"
Rear track, coupe	49.0"
Rear track, wagon	50.2"
Curb weight, coupe	1970 lb.
Curb weight, wagon	1950 lb.
Fuel capacity, coupe	10.6 gal.
Cargo capacity, coupe	15.7 cu. ft.
Cargo capacity, wagon (rear seat up)	34.0 cu. ft.
Cargo capacity, wagon (rear seat folded)	52.6 cu. ft.
Engine type	4-cylinder inline
Displacement	1400cc/ 85.2 cu. in.
Horsepower	80 at 6000 rpm
Torque	83 at 3600 rpm
Compression ratio	8.5:1
Emission-control systems: Catalytic converter, air pump, dual idle compensator, exhaust-gas recirculation, electric fan for carburetor heat, automatic choke.	

Datsun has two more models to throw into the U.S. small-car market: the F-10 hatchback coupe and station wagon. They feature the same low fuel consumption as the B-210, but are unique in offering front-wheel drive, a first for Datsun in this country.

The coupe is about the same size as the B-210, but because of front drive, has a longer wheelbase and is slightly shorter overall—155.5 inches compared with 163 inches for the older model. The wheelbase is 94.3 vs. 92.1 inches. The F-10 uses the same high-efficiency 1400cc four-cylinder engine and gets 40 mpg-plus in the EPA highway ratings. City driving rates 29 mpg.

Next to fuel economy, the big story is the drive train. The coupe has a five-speed manual transmission, while the wagon has a four-speed manual. Datsun is not yet offering an automatic in these cars. Final drive gear on both transmissions has a 1:1 ratio, which seems a contradiction on the five-speed, since fifth gear could easily be built as an overdrive. The result would be even better highway fuel economy.

Datsun officials point out, however, that the gear ratio in the rear axle is a more economical 3.45:1, which gives better fuel economy than the B-210 and also improves ride quietness at highway speeds. The B-210 has a 3.89:1 axle ratio.

On the coupe, all four wheels are independently sprung. Front wheels have strut suspension with coil springs, while trailing arms with coil springs are used in the rear. The result is a soft-riding car that adapts itself well to different road surfaces. But during a familiarization run on rough roads I noticed considerable mechanical noise coming from the rear suspension. It was not evident in the station wagon.

The same strut-type front suspension is used on the wagon. But the rear suspension is a solid-beam type that's much stiffer, and it's less forgiving on rough surfaces. The likely heavy-duty use of the wagon dictates the more rugged design.

Datsun has put special emphasis on controlling noise. While no instrumented tests were conducted, I did notice less road noise and an absence of wind whistle inside the coupe. Combined with a tightness of body and suspension, this made for a pleasantly quiet ride on smooth roadways, notable in a car of this size and price—in the mid-\$3,000 range.

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Braided composite fishing line

...is it 'so long' to monofilament?

The braid is back in fishing line. And it's back as a spinning line. Cortland's new Polyspin is no ordinary braid, however. It's a whole new concept in fishing line, developed by Cortland's head research scientist, Dr. E. P. Scala. Polyspin, says Dr. Scala, is braided nylon fibers combined with a matrix of resins. This makes it a fiber-resin composite, much like those super-strong graphite-epoxy composites [PS, Apr. '75]. In Polyspin, however, the resin matrix doesn't completely saturate the braided fibers of the line. That would make the line too stiff. In fact, when I examined Polyspin under a microscope, no matrix was visible at all. But something is there, binding all those fibers together. You can feel it in the slight stiffness and the homogeneity of the line. Just what that matrix is, they won't say.

Cortland turned to the composite approach for a good reason. Modern mono has been improved about as much as possible. "Composites give you another dimension in material to work with, new variables," says Dr. Scala.

I've tested Polyspin, both in actual fishing and in my shop. Out

on the water it handled just about like a high-grade mono—with one improvement: It has much less tendency to take a set on your reel's spool. When you cast, it lays out nicely, with none of the corkscrew coils you can get with mono.

In my shop I tested Polyspin for tensile strength, knot strength, and diameter, just as I did with monofilament lines [PS, June]. Results for 10-pound Polyspin: Tensile strength: 11 pounds, eight ounces. Knot strength: Seven pounds, 12 ounces. Diameter: 0.035mm. Again, these figures compare with those of a top-grade mono.

The diameter seems high at first, but there's a bit of a hitch here. Being braided, Polyspin doesn't hold a round cross section the way mono will. On your spool it will mush down slightly, conforming to the space around it. As a result, it packs neatly on a spool and you'll find you can fit as many yards of Polyspin on your reel as you can of a mono with a smaller diameter.

I also tested Polyspin against Du Pont Stren for casting distance. After measuring 10 casts with each line I could detect no advantage for either.—A.J. Hand



Cortland Polyspin is a new braided line developed for spinning reels, but it's good on revolving-spool reels, too. Comes in tests from four to 30 pounds. Price: about the same as for a premium monofilament. Knots for Polyspin are the same ones that work best with mono. Improved clinch knot tied with 10-pound Polyspin is shown at left.

Microcam —lightest, smallest electronic TV camera

As TV cameras shrink, their versatility expands. The new Microcam has been scaled down to the size of a hand-held movie camera without sacrificing the picture quality of a studio camera.

The eight-lb. Microcam is half the size and weight of its forerunner, the Minicam, and it's less than half the cost, with a price tag of under \$30,000.

The Microcam operates on only 22 watts. That means a three-lb. electronic hip pack, attached to a battery belt, can replace the cameraman's familiar heavy, bulky backpack. In emergencies, the Microcam can operate on flashlight batteries. With eight pounds of lithium D batteries in the belt, the Microcam can operate continuously for 40 hours.

Built-in filters monitor color. This sharpens the image and frees the camera operator from

color balancing and other manual tasks.

The camera's output can be either videotaped or transmitted directly back to the studio and broadcast live. Since the Microcam is so light and easy to handle, some TV news-gathering operations may give up film cameras entirely and switch to making videotapes on location. That would eliminate the necessity for film processing, speeding up the whole news-reporting process.

Microcam's commercial broadcasting debut is set for the Democratic National Convention in July. The lightweight camera is expected to boost job opportunities for women in the male-dominated broadcasting field. Its developer is Thomson-CSF Laboratories, Stamford, Conn., in cooperation with the CBS television network.—Susan Bronson



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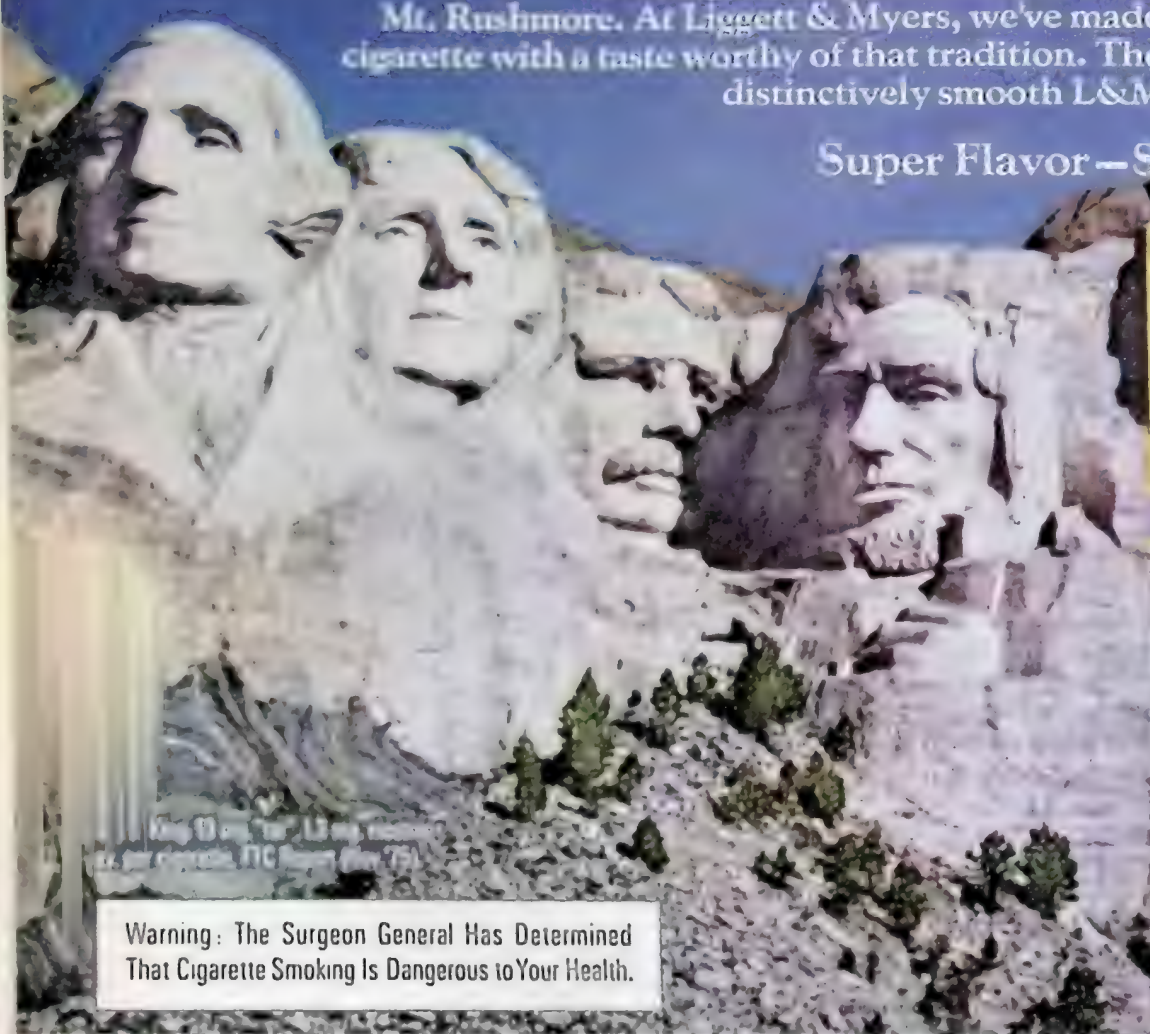
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PS | What's News

Our cover picture shows the biggest photographic news item since the introduction of Polaroid's SX-70 [PS, Jan. '73]. We got our hands on one of the first new Kodak EK6 instant-picture cameras later than our normal deadline for the July cover. We received the camera about noon. After several of us had shot a number of pictures with it, we decided the news was important enough to rush it into July so you could read about it at about the same time you began seeing it in your favorite camera store. We drafted one of our staff members, Elizabeth Bendall, to pose with the camera, shot the cover picture, and sent it to the processor that afternoon. We had several days more to give the camera a thorough workout before Ev Ortner wrote his report beginning on page 54.

Man-powered aircraft

"Who will take aviation's richest prize?" asked an article in *Popular Science* of February, 1974. That prize is still unwon. In 1960, British industrialist Henry Kremer offered £5000 to the first person to fly a man-powered aircraft over a figure-eight course around two markers a half mile apart. Kremer upped the ante to £10,000 in 1967 and to £50,000 in 1973. Although some 15 man-powered aircraft have been constructed and flown since 1961, no one has even attempted to fly the Kremer Prize course. The task seems almost impossible. However, lured by the prize money, people continue to build man-powered planes.

Latest to fly is the *Olympian*, built by brothers Joseph and Clarence Zinno. On April 21, 1976—in a man-powered flight hailed by the press as the first in U.S. aviation history—Joseph A. Zinno, a 52-year-old retired USAF colonel of Centerville, R.I., pedaled his craft into the air on a five-second flight that carried him less than 100 feet, reaching a height of about 12 inches above the ground. A single-seat monoplane built of balsa and aluminum, the *Olympian* has a span of 78 ft., 6 in., is 21 feet long, and weighs about 150 lb. The plane represents an investment of over 7000 man-hours and about \$5000. Zinno plans further trials—and maybe someday a crack at the Kremer Prize.

Did you know?

It took only 30 years for television to come

to rival both the telephone and automobile in worldwide popularity. Based on latest statistics available, there are estimated to be 364 million TV sets in the world, compared with 360 million telephones and 300 million autos and trucks. Commercial television began in 1946, the telephone got its start 100 years ago, and the auto has been around for about 80 years. I remember one of my physics profs telling me that TV would never be anything but a rich man's toy.

GM's rotary engine

Although the introduction of GM's version of the Wankel engine [PS, Apr. '74] was postponed, the project is not dead. Research continues. Progress has been made in the last year in reducing hydrocarbon emissions without compromising fuel economy. But not enough, yet, to meet anticipated federal standards. A series of test engines was designed, built, and put through paces to study the effect of variations in engine geometry on hydrocarbon emissions. The geometry providing the best fuel economy and lowest emissions resulted in the largest engine-package size. Conversely, the smallest package-size configuration gave the poorest emissions and fuel economy. All gave lower oxides of nitrogen emissions than comparable piston engines. Research continues.

Once more: the greenhouse effect

Seldom has a subject in this column generated such interesting mail as the two earlier discussions of the greenhouse effect. Comment has ranged all the way from that of a man who thought I was saying that greenhouses don't work (I did not), to a highly technical discussion from an infrared physicist who personally had run transmission curves for window glass and sodium chloride. He sent along graphs showing that the reader I quoted in my May column was wrong in stating that rock salt and window glass would be equally opaque to reradiation from warm objects inside the greenhouse. Letters from other scientists assure me that glass does indeed act as a one-way trap for radiant solar energy. They talk of recent work on solar/thermal systems incorporating the performance-enhancing technique of selective absorption. No argument. No one quarrels with the fact that there is such a thing as radiative

trapping or selective absorption. In carefully engineered systems operating at temperatures substantially higher than those found in a greenhouse, selective absorption may be dominant. But should we continue to call this the "greenhouse effect" if selective absorption accounts for only a small portion of the heat gain in an ordinary greenhouse? Professor Wood, in the article I referred to in May, said he published his note to "draw attention to the fact that trapped radiation appears to play but a very small part in the actual cases with which we are familiar." Another scientist wrote to me: "Under most conditions the radiative trapping effect of glass is quite important." With many laymen becoming interested in harvesting solar energy on a do-it-yourself basis, and many new materials becoming available, it is of more than academic interest to know just how important radiative trapping is for low-technology devices. As still another scientist wrote to me, "It is high time that this matter be settled scientifically." If anyone has acquired numbers from actual experiments, I'll be pleased to publish them in a future column, with attribution. Incidentally, I do not ordinarily publish correspondents' names unless they give me specific permission to do so in their letters.

Energy from the sea

While the U.S. government has yet to show any enthusiasm for wave power, the British government has said it will spend the equivalent of \$1.6 million over the next two years to find out if sea waves can be used to generate electric power economically [PS, May '75]. British scientists at the Department of Energy now believe that wave power holds more promise than tidal power. The Salter vane system and the wave pump described in our article are among the four devices being investigated. The scientists estimate that it would take 10 years to develop and build a prototype generator after they had decided which scheme was most promising.

Hubert P. Luckitt

Editor-in-Chief

Solar architecture

—it's more than putting collectors on the roof

Energy-conserving design and construction are prerequisites for solar homes. Here's a sampling

By RICHARD STEPLER

LITTLE COMPTON, R.I.

The March fog lay thick around Junius and Louise Eddy's contemporary home. I was talking with the Eddys in their new solar-heated addition, behind the ductwork that led to and from the solar collectors on the addition's sloping, south-facing facade. Suddenly, there was the sound of an electrical connection being made, and a heavy, muffled rumble as a powerful fan began moving air from the collectors to a rock-filled storage vault beneath our feet.

"We're collecting!" exclaimed Louise.

In spite of the heavy fog that had blanketed the Rhode Island coast all morning, the Sunworks air-type solar collectors had accumulated enough of the sun's heat to cause the system to actuate itself for a few minutes' collection.

I was visiting the Eddys as part of a trip that would take me to see solar homes scattered around the Northeast. Solar energy has clearly moved out of the laboratory and into homes [PS, Mar. '74]. Manufacturers have been selling off-the-shelf hardware for more than a year [PS, Mar. '75]. Now I wanted to see practical applications—talk with architects who design solar homes and the people who live in them.

Not that solar homes are strict-

Continued



1 New Hampshire farmhouse, with Beadwall addition

2 Rhode Island contemporary, with air-type collectors

3 Passive solar in New Hampshire with Beadwall

4 Oklahoma contemporary, with liquid-type collectors

5 Vermont vacation home, with Grumman collectors





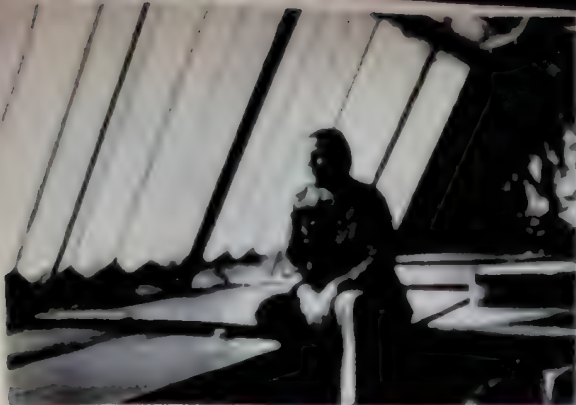
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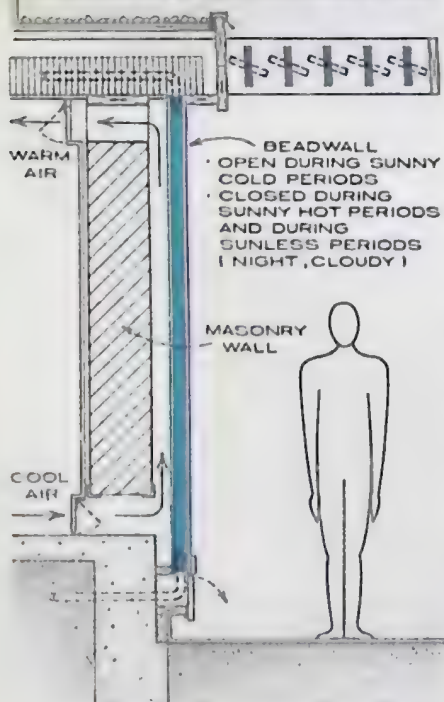
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For details on the solar-heating systems
of these homes, turn the page

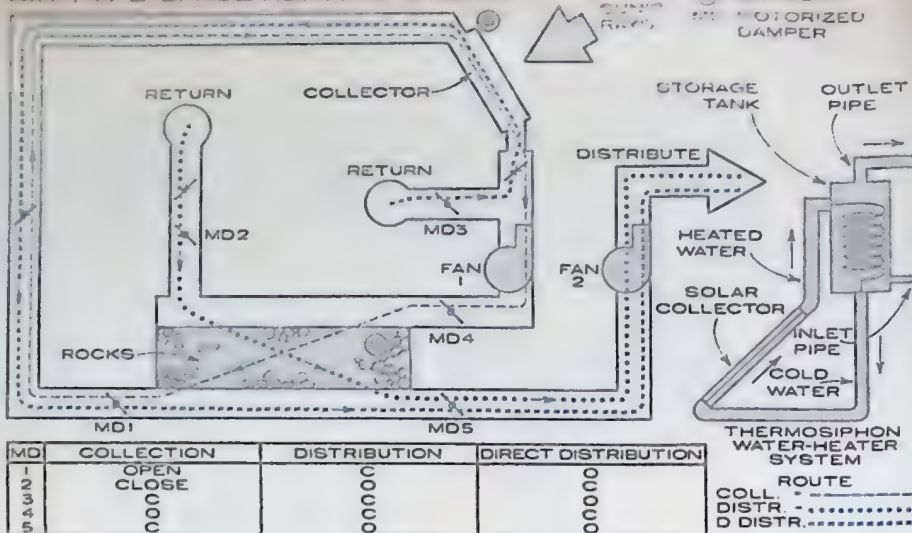


Insulated attic, with 14 waterbeds, is heat storage for renovated farmhouse. Architect Bruce Ellis (here) chose Beadwall as collector for simplicity, low cost. System operates automatically via heat sensors, thermostats.



3 Passive approach is typified in TEA's partially underground house. Entire house acts as storage, collecting heat that comes through windows. Bead-wall panels. Only moving part of system: tiny polystyrene beads blown into or sucked out of panels. Architect Doug Coonley points out PVC manifold beneath panels. Cutaway shows air movement: Cool air enters at bottom, rises by natural convection, exits at top. Masonry wall behind panels can reach 100°.

AIR-TYPE SPACE-HEATING SYSTEM



2 Sunworks air-cooled collectors—378 sq. ft.—provide space heating for 2000 sq. ft. of living space. Domestic hot water is supplied by a separate system, which uses three (63-sq.-ft.) Sunworks liquid-cooled collectors, op-

erating on thermosiphon principle—warm water rises and cooler water falls. Water and antifreeze solution circulates from collectors to heat exchanger in a storage tank located two feet above collectors. Electric water heater is backup.

ly an east-coast phenomenon. Ironically, I talked with an architect who is busy designing solar homes in oil-rich Oklahoma. And on the west coast, Joe Zmuda checked out Interactive Resources, Inc., a multidisciplinary team of engineers and architects that is designing and building solar homes in California. Turn the page for his report.

One fact became readily apparent in our research: Going solar means a radically different approach to housing. The architects we talked with all agreed that solar homes should be designed from the ground up to be energy conserving, as opposed to conventional housing, which conquers the environment with relatively massive doses of energy.

Bruce Anderson, president of Total Environmental Action (Harrisville, N. H.), a group of architects working at practical applications of solar and wind energy, put it this way: "I really hate to talk about applying solar to houses designed to FHA standards. For example, a typical FHA home—three bedrooms, 1400 sq. ft.—would take from 500 to 700 square feet of collectors to save half the heating bill. The same size home, designed to be energy conserving, would cut energy requirements by 50 percent and would need only 250 to 350 square feet of collectors to provide half its heating requirements."

Home sweet collector

How is a solar home designed to be energy conserving?

- Solar homes are designed and oriented to serve as collectors themselves. They admit winter sun and are sheltered from prevailing win-

ter winds. In summer months, they exclude the sun and have provisions for natural cooling.

- They have few or no windows on the north side. Most glass area—double or triple glazing—is on the south-facing facade.

- They have extra insulation in walls and attic.

- Earth may be back-filled to partially or completely cover north, east, and west walls.

- Heat lost through windows at night is cut by insulating shutters—or drapes.

- The amount of cold (or warm) air entering the house when doors are opened is reduced by airlock entries (see PS, Sept. '75 for double-door vestibules you can build for your own home).

- Air infiltration is minimized by careful construction, and by caulking and sealing all measurable air leaks.

- Solar homes have close-in, multistory floor plans rather than sprawling, single-story designs.

These energy-conserving features obviously place design constraints on solar homes. But architects are meeting the challenge in varied and exciting ways.

Subterranean living

One way to protect a home from cold winter blasts and keep it cool in summer is to build it underground [PS, June '74] or partially underground [PS, Dec. '75, and box, overleaf]. An underground house has drawbacks, though: little or no direct sunlight admitted and no provision to integrate solar collectors with the structure.

A partially underground house,

however, can have windows and solar collectors on a south-facing facade, while north, east, and west walls are completely or partially covered with earth. Such a home is the one designed by Architect Doug Coonley of Total Environmental Action (#3 on the preceding page). This house is its own solar collector and heat-storage system. Explains Coonley:

"Windows and collectors admit sunlight, and the heat is stored in the four-inch-thick concrete floor and foot-thick concrete walls. The walls are insulated on the outside with two inches of rigid styrofoam insulation, and act as a heat-storage mass."

The vertical solar collectors alternate with windows on the south wall (see photos). Called Beadwall (developed by Zomeworks Corp.), the collectors consist of two sheets of translucent fiberglass-reinforced plastic separated by an air space. At night or during cloudy periods, tiny polystyrene beads are blown from drums in the garage into the air space by vacuum-cleaner motors. This makes the panel an efficient insulator, holding heat inside the house. When the sun is shining, the beads are sucked out, back to the drums. The empty panel lets the sun heat the masonry wall behind it (see drawing).

Other features of the house: natural cooling by venting from the shaded north side; insulating shutters for doors, windows; airlock entry through the garage; domestic-hot-water preheater—75 feet of PVC embedded in collector wall; two Austrian wood stoves to provide backup heat for the house.

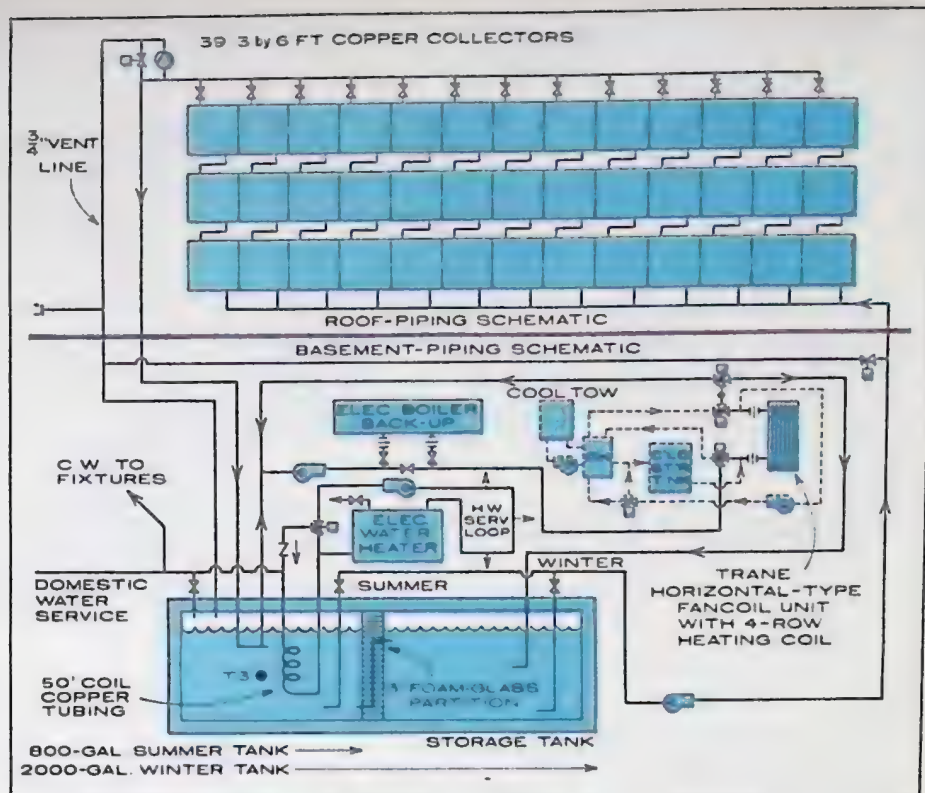
The house—three bedrooms, 2000 sq. ft.—cost \$52,000 to build, including \$5000 in design fees. Coonley estimates that the energy-saving features and solar components added \$5000 to \$7000 to the cost. The Tyrrells, the owners, figure they'll get back the extra investment in reduced operating cost over the life of the mortgage.

Down on the farm

Beadwall is also being used in an addition to a renovated farmhouse near Concord, N.H. (#1 on preceding page). Architect Bruce Ellis of Concord designed the home with TEA advising. "I looked at other solar systems," says Ellis. "They were too complex. I just wanted to heat space."

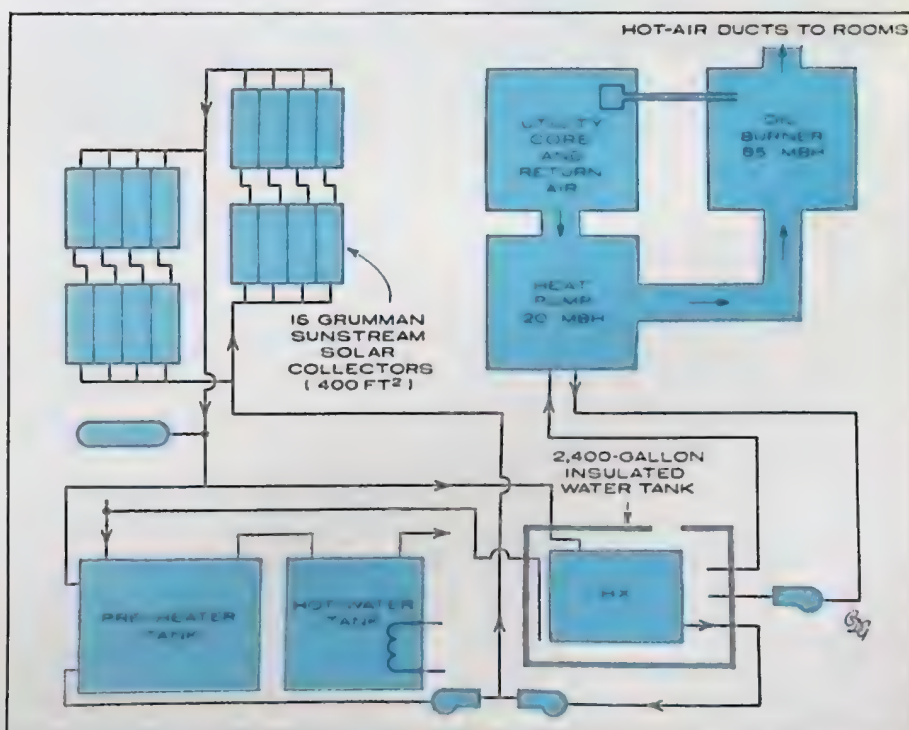
And the system he and TEA devised is simple: Beadwall panels cover most of the addition's slop-

Continued



4 Space heating for Oklahoma home is provided by pumping hottest water from 2000-gal. storage tank through fan-coil heating unit. Fan blows air across coils into ducts to distribute heat to house. Electric boiler comes on in stages to maintain water at 95° if needed. System is direct, circulating the stor-

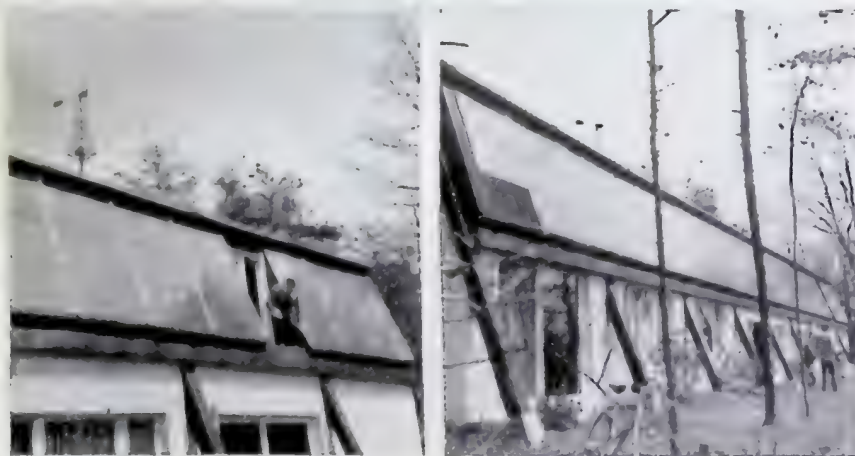
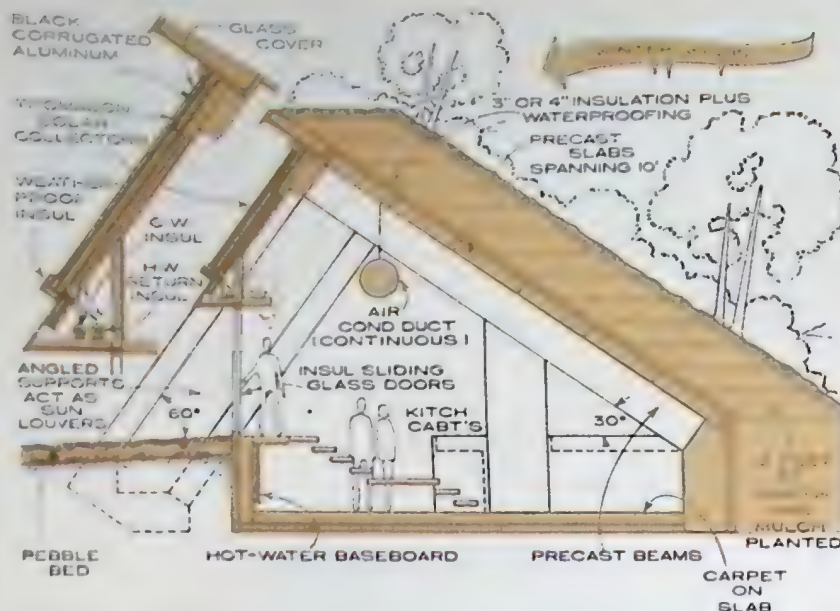
age medium—water—through copper collectors. Domestic hot water is preheated in storage tank. In summer, storage is 800-gal. section of tank so that higher storage temperatures—at least 195°—can be maintained to supply heat source for lithium-bromide AC unit (dotted lines on schematic).



5 Aluminum-corrosion problem is eliminated with special distilled-water/antifreeze solution, claims Grumman. Fluid circulates through collectors to heat exchanger in storage tank, which supplies 45° to 80° water to the heat pump. Oil furnace is backup. When 80°

storage temperature is reached, domestic hot-water preheater is actuated. [See also PS, May '76, page 104 for schematic of Grumman's solar hot-water system.] Solar heating system is sized to provide 50 percent of the home's hot-water and space-heating requirements.

A solar home you can build



Combine the efforts of architect Malcolm Wells; solar pioneer Harry Thomason; Edmund Scientific, the mail-order company; and Bob and Nancy Homan, enthusiastic new solar-home owners: The result is an ecologically sound, practical solar-heated home that anyone can buy plans for and build.

Architect Wells is an advocate of architecture that has minimal site impact. The home he designed for the Homans (see photos and drawing) is located on a gentle south slope, with a dense grove of pines to the north to shelter it from winter winds. The roof is covered with a layer of earth and mulch, planted with vegetation native to the area. This returns the site in part to its natural state, adds insulation, reduces rain runoff.

Thomason solar collectors run the length of the home's sloping, south-facing facade; water circulates from them to a tank buried in a rock storage bin. Air is blown through the rocks, picks up heat the rocks have absorbed from the tank, and is ducted to the living area. [See PS, Mar. '74,

for description of Thomason's home.]

The Homans' house is divided into two areas: day activity (kitchen, dining and living rooms, and studio) and night activity (bedrooms). The solar-heating system has two blowers, one for each zone, so that each can be heated to different temperatures.

The Homans have been living in the house for a year. I asked Bob how it was working. "We're very pleased," he said. "We figure we're getting 85 percent of our heat from the Thomason system."

He adds that they've spent \$60 on oil for backup heating—and that heating with oil alone has been estimated at \$750. Even considering the extra expense for solar (\$5500 out of a total \$60,000 for the house), it adds up to impressive savings.

All this is great for the Homans, but how about the rest of us? That's where Edmund Scientific (700 Edscorp Bldg., Barrington, N.J. 08007) comes in. They've published a book (\$24.95) with detailed drawings your architect can work from. A license to build the house is \$40.

ing, south-facing roof. When it's sunny, a heat sensor located behind one of the panels causes the beads to be vacuumed out of the panels via PVC pipe to storage drums elsewhere in the attic. (Color photos show panels both filled and empty.)

The attic is the heat-storage "tank." It's heavily insulated—10 inches in the roof, 12 inches between the attic and the living space below. Fourteen waterbeds (not for sleeping), holding 21,000 gallons of water, cover the attic floor, absorbing and storing heat. When heat is needed, a fan draws air from the attic and distributes it via ductwork. An air return in the attic floor completes the cycle. Ellis figures there's enough storage for three cloudy days before the backup system—the farmhouse's existing oil furnace—would be needed.

Going solar added about \$8000 to the cost of the renovation, mostly in extra structural members to support the water, and for the added insulation: 2x6's in walls and 2x12's for roof framing.

The sun will provide about half the energy needed to heat the house, or save \$600 of a \$1200 annual cost for fuel oil, Jackson Freeze, owner of the house, told me. In addition, Dr. Freeze figures he'll save between \$450 and \$500 annually in real-estate taxes because of a special deduction the City of Concord allows for solar heating systems. It works out to a pay-back period of eight to nine years—at present oil prices.

Solar addition

The Eddy house in Rhode Island demonstrates another approach to solar retrofitting (#2 on color pages). The existing home is all-electric, but poorly constructed. "Air infiltration was incredible," says Junius Eddy, "so much so that on extremely cold and windy days, we couldn't maintain an inside temperature above 54°. And our electric bills were running from \$300 to \$400 a month."

The Eddys asked designer Travis Price to build an addition that would be solar heated. In winter, when they needed less room (no visiting children), they would heat only this addition, plus three rooms in the existing home.

"The addition is extremely well insulated," says Price, "with three inches of sprayed polyurethane on the foundation, 3½ inches of fiberglass batt plus one inch of styrofoam on all exterior walls, and

[Continued on page 96]

Solar architecture, a western approach

By JOSEPH ZMUDA

The trend to custom solar design on the West Coast is typified by the work of a team of architects and engineers in Point Richmond, Calif., named Interactive Resources, Inc. In addition to serving as consultants in more than two-dozen solar-heating projects, the firm has 10 solar homes under construction or being planned. IRI totally integrates all phases of a custom solar home, providing comprehensive planning and construction services.

The firm's president, Thomas K. Butt, has completed extensive economic analysis that shows a solar-heating system is the most economically viable one for a new home. "You pay more for it," he says, "but over a given period of time, you'll realize a distinct savings."

Anyone walking into IRI with preconceived notions of what he wants his solar home to be like might end up with a design that is far from his original conception. Initially, the client is questioned about what he wants: rooms, baths, windows, and so on. Then, because the client should really be interested in the concept of saving energy, he is given an education as to how his future home *must* be built: with proper orientation to the sun to maximize passive solar heating; and deemphasis of large window areas, especially on northern walls.

Once the "program" of the home has been decided, the structure can be designed and the solar heating system planned. Multistory homes with a close-in rather than sprawling floorplan are preferred, with a minimum of glass area and liberal use of insulation.

IRI engineers then decide which solar collector and storage components will be most efficient, economical, and aesthetic. Off-the-shelf hardware may be specified; however, less-costly custom systems will probably be fabricated.

I made a visit to the first solar home to be completed by IRI, a three-story private residence high on a ridge in the hills of northern California (see drawing). The en-

tire south-facing, slanted roof comprises a flat-plate solar collector of corrugated-metal sheeting covered by a layer of clear fluorescent light tubes. A cutaway of the collector is shown above.

Water from a 3000-gallon concrete storage tank under the house is pumped up to the roof and allowed to run over the black-painted metal collector. When the water becomes hot enough, it can be circulated through a fan-coil forced-air heating system. A separate collector supplies the hot-water heater.

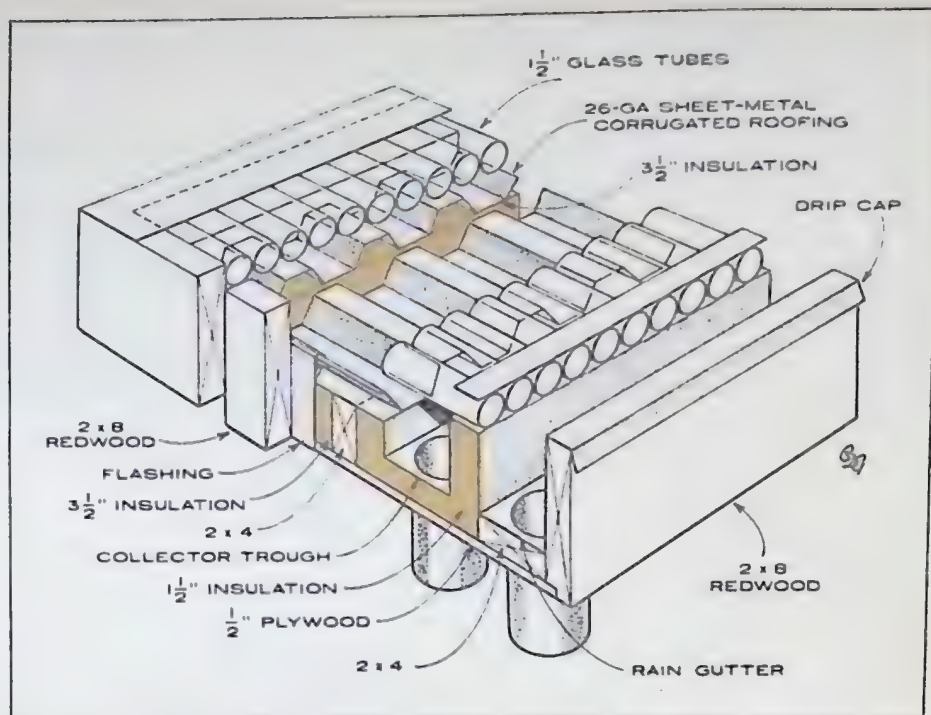
Enough energy can be stored for three sunless days, accounting for 90 percent of the home's heating and hot-water needs. A conventional gas-fired heater provides backup.

According to Butt, this is perhaps the first large-scale solar project to use fluorescent tubes in place of sheet glass. I discovered a few drawbacks. Overall efficiency isn't the best possible, and water is gradually lost through evaporation. But the tubes are easily replaced in case of damage. Also, the low initial cost of the collector—\$2.70 a square foot installed, compared to three to five times that for other commercial products—makes it attractive.

But competition for a portion of the solar-building market has been appearing all over California:

- A "solar subdivision" is taking shape in El Cajon, Calif. Energy Systems, Inc., is constructing 22 homes, that feature solar space, pool, and hot-water heating.

- Village Homes is a project being undertaken in Davis as an in-



novative neighborhood dedicated to conserving energy and resources. South-facing lots will permit maximum efficiency from rooftop solar collectors. Project developers Michael and Judy Corbett built the first low-cost solar-heated house in northern California.

- Harold R. Hay, whose Skytherm solar house was featured in PS, Mar. '74, now has improved plans that adapt his unique rooftop system to two-story use in mild climates. According to Hay, "The full report of the Atascadero home has been released to HUD by California Polytechnic. It states what can be claimed for no other solar building, that this one had 100-percent heating and cooling, with comfort far superior to air conditioning and distinctly superior to gas heating, and that this house has the potential, in mass production, of costing no more than a conventional home."

How does it work?
How does it compare?

Kodak's instant-picture camera

Now, after six years in the lab, there's a Kodak system. Is there a new champ, too?

By EVERETT H. ORTNER

You press the shutter button and release it. There is a pause, then the wheeze of an electric motor. A square of blank paper slides out of the camera. Eight minutes later, it will be a color photograph.

Inside the camera, when you pressed the button, the shutter blades opened to expose a reversal-type color film, a multilayer sandwich of dyes and dye releasers, activator, and neutralizer. When you released the shutter button, rollers inside the camera began to push the film out. A pod of chemicals—alkali and developing agent—at one end of the film sandwich burst as it went through the rollers, and its contents were squished through the film, the excess ending in a trap as the film left the rollers. Eight minutes later, with the dyes now in place, the color print was 90-percent ready for your album.

Does all this sound as if you have been taking a picture with a Polaroid SX-70 camera?

Yes, says the Polaroid Corporation, which has filed suit against Eastman Kodak, charging that Kodak's new instant-picture system infringes on 10 Polaroid patents.

No, says Kodak, which has now, after a half-dozen or so years of promises (threats?), introduced its own instant-picture system. Indeed, two weeks before the introduction, Kodak's Canadian subsidiary filed an action in Canada to have nine Polaroid instant-picture patents declared invalid.



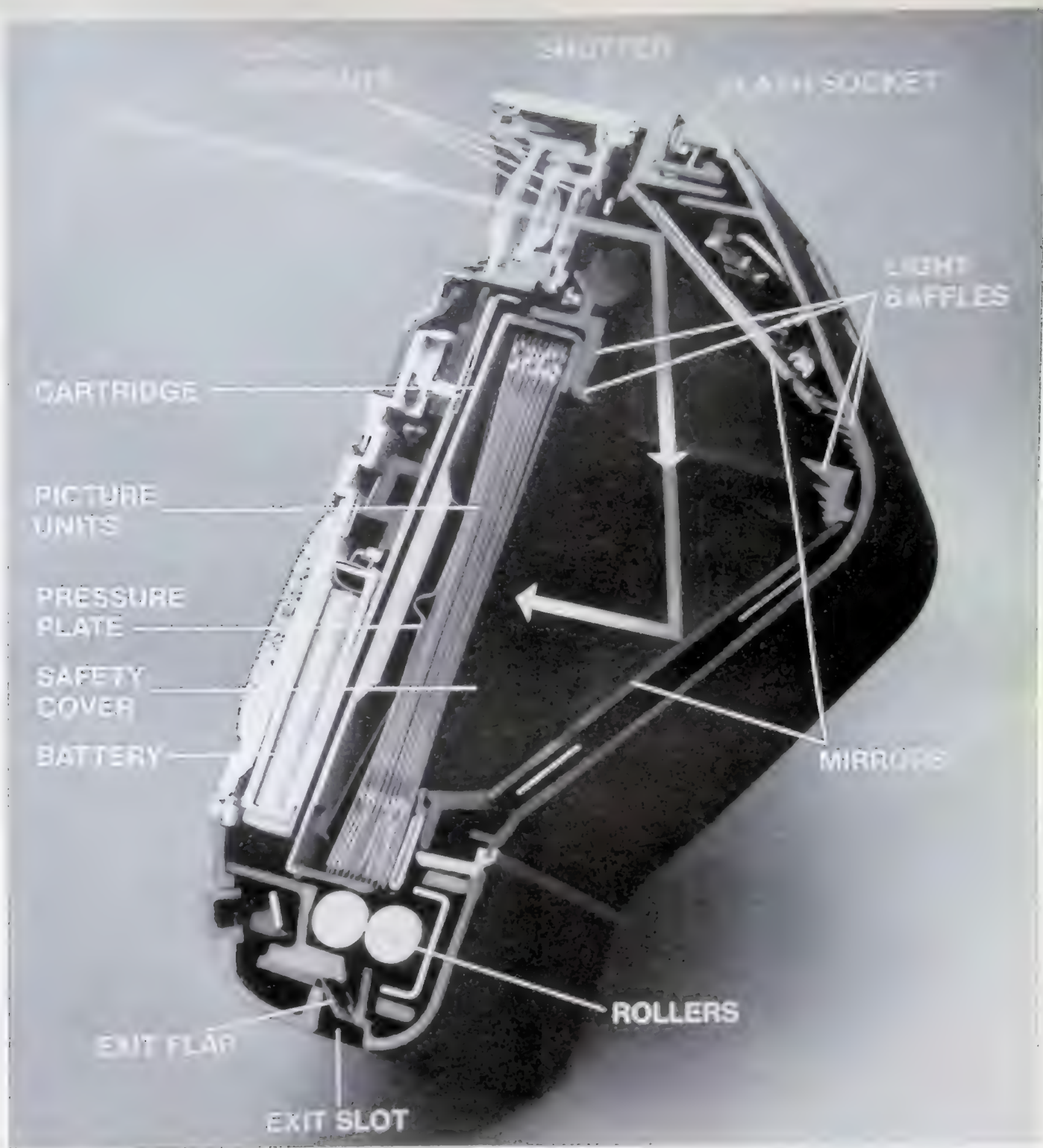
Only the courts can determine the issue of patent infringement. What is certain, however, is that Kodak has created its own miracle system that can challenge in almost every respect the SX-70 system.

The film: its own darkroom

Kodak's PR-10 film pack is litterless—like that of the SX-70. Each picture contains its own darkroom: One wall is a curtain of carbon drawn across the back of the film by the activating fluid when the

pod is burst; the other wall, near the front, is composed of a black layer and a white reflective layer (which provides the whites of the picture). The chemicals and dyes stay within the picture, some visible, having migrated to the "image-receiving" layer, others invisible below the black opaque layer.

There are other similarities between Polaroid and Kodak films: Both have an exposure index of 150. Both offer 10 pictures to a pack. Developing times are approxi-



mately the same—90 percent complete in about eight minutes at room temperature.

There are two major differences: print dimensions and, in Polaroid's SX-70 film, a battery.

First, the print dimensions: Although image areas in both systems are almost the same (9.8 sq. in. for Polaroid; 9.4 for Kodak), the Polaroid print is a 3 1/4 in. square, the Kodak a 3-9/16-by-2 5/8-in. rectangle. Which is better? Photographers who think in terms of

"vertical" and "horizontal" pictures will prefer the Kodak proportions. Obviously, it's a matter of taste.

But the presence or absence of a battery in the film pack is a matter of considerable significance, in light of the designs of the two systems and the experience since 1973 with Polaroid's SX-70 film.

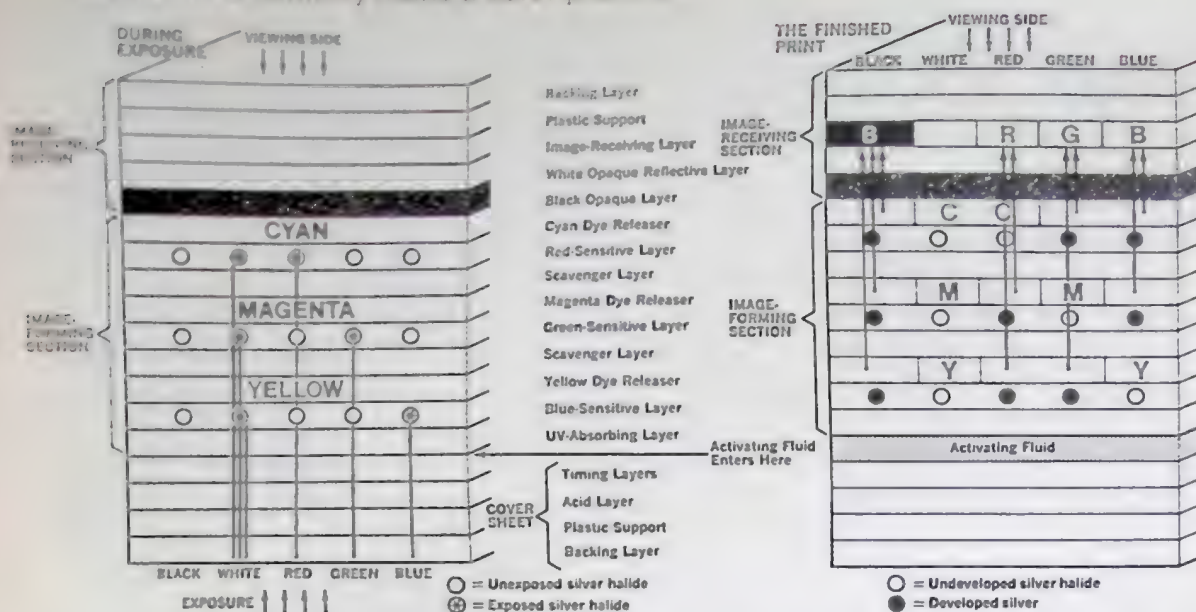
Always a fresh battery

The concept behind the SX-70 design is a daring one. It goes like

Continued

"Folding" the lens-to-film light path with mirrors shortens the front/back dimension of Kodak instant-picture camera, but still leaves a hump. Film pack holds 10 sheets in place, pressed flat by pressure plate. Film safety cover is ejected after loading. Exposure is through the rear, after which print is rolled out of the camera (manually in the EK 4, by motor in the EK 6). Pod end of film is visible at the bottom. As it squeezes through the rollers, it ruptures and the film's activating fluid squishes through, the excess ending in a "trap," visible at the top of the film. System is litterless.

Light and chemistry make a color picture



Film cross section, far left, shows what happens as light, from back (bottom, here) of film, penetrates color-sensitive layers. Grass, for example, exposes silver halide in green-sensitive layer; white exposes halides in all layers, black in none. Processing is started by activating fluid; it also carries carbon that, with opaque layers, creates "darkroom." Only unexposed halides develop, turning into silver and releasing dyes in layers directly above. Dyes, of subtractive primary colors, migrate and combine into additive primaries: Thus, cyan and yellow form green of grass.



Loading is simple: Line up stripe on film pack with stripe on the compartment, and push. Batteries—two six-volt size J for EK 6—fit above film.



Hand crank to roll out film is sole difference between \$53.50 EK 4 shown and the \$69.50 motorized EK 6. Four turns do the motor's job and save \$16.

this: Since a major cause of camera failure is weak or dead batteries, why not insure that the user always has a working battery by packing one with the film itself—a fresh battery built into every film pack?

The major argument against the concept, which was less obvious four years ago than it is today, is: Putting color film and batteries—both of them time-sensitive elements—into one package multiplies the risk of failure. Color film deteriorates. Colors change. Much worse, batteries expire, and the camera, dependent on the film-pack power source, is useless. This was particularly true in the early days of SX-70, when the batteries were made by an outside supplier and battery failure was a major headache. Polaroid now makes its own batteries, and claims the problem has been largely eliminated.

The aging problem is of concern not only when purchasing fresh

film but when using it. In millions of homes, the camera is taken out of the top dresser drawer for a birthday or graduation, then tucked away until Thanksgiving or Christmas. Months may pass, and the film pack that magnificently recorded Grandma's birthday party may refuse to capture the Thanksgiving turkey.

If all other aging factors are equal, the useful survivability of a Kodak film pack would seem to be greater than that of an SX-70 pack. Perhaps as evidence, film distributed by Kodak in April, when the system was introduced, bore a "use before" date of May, 1977. The Polaroid use-before date in April was January, 1977.

In two perhaps less significant areas, Polaroid has an advantage. First, SX-70 film has a greater temperature latitude (45-95° F., compared with Kodak's 60-90°). In slightly chilly early-fall days, you don't have to put the film in your pocket while it develops. And secondly, SX-70 film is cheaper: \$6.99 for 10 exposures, vs. Kodak's \$7.45.

The cameras: manual or auto

What about the new Kodak cameras? There are two at this time, the EK 4 and the EK 6. They differ in one important respect: The EK 4 has a hand crank. Four turns roll the print out of the camera. In the EK 6, an electric motor does the turning.

The cameras have an unusual shape: a cigar box with a bulge at the back. The bulge is to accommodate a "folded" light path—the



Pronto—the competition from Polaroid—sells for \$66. At 16 oz., it's far lighter than the two Kodaks, which weigh in at 26.7 (EK 4) and 29.1 oz. (EK 6).

Gearless transmission

—steel belt and pulleys make it automatic

By DAVID SCOTT

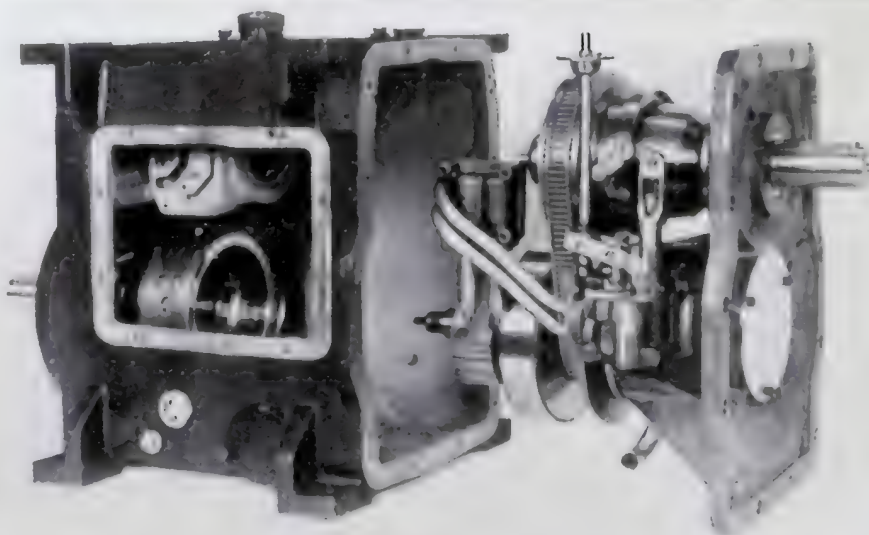
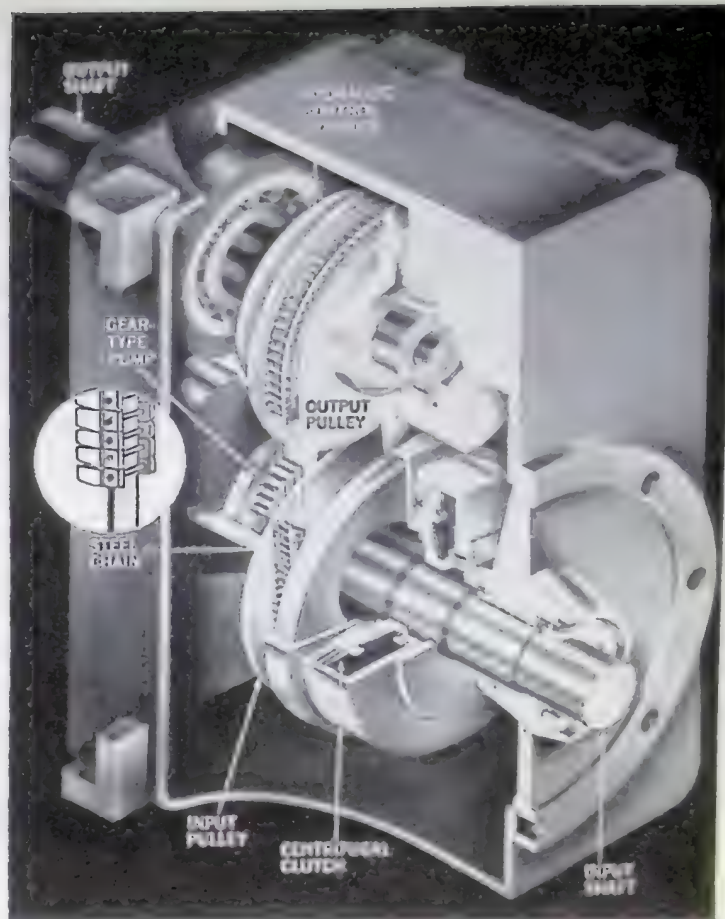
How about a shiftless transmission that varies gradually from low to an overdrive ratio without gears? Smoother running, greater efficiency, and the optimum ratio for every road condition—that's the promise of Transmatic from Van Doorne in Holland. It's a clever steel-belt version of the stepless Variomatic long used in small DAF (now Volvo) cars.

Compact construction means it could easily replace the manual gearbox of small front-drive cars with transverse engines, like the new VW's. Transmatic can handle high torque at input speeds up to 8000 rpm. And with a centrifugal clutch instead of the usual torque converter, power losses and therefore fuel consumption are lower. The all-mechanical drive is also simpler, lighter, and quieter than other automatics.

Uniquely, the steel belt connecting Transmatic's two tapered pulleys transmits force by thrust, not tension. That means a hefty power-handling capacity, no stretch or risk of breakage, and very little wear. The belt's V-shaped blocks are hydraulically clamped between the pulley disks as they rotate. Because they're so short, a large number of them make frictional contact around the pulleys' rims for a solid grip. The belt's guide loop, laminated steel bands, runs around the pulleys at a slightly slower speed than the blocks.

Transmission ratio at any particular moment is determined by the relative diameters of the two pulleys. You get "low" when the engine-driven input cones are spaced wide apart (small diameter) and the output cones connected to the wheels are close together (large diameter). The Transmatic gradually changes into "high" as input-cone diameter increases and output-

Input shaft transmits power through centrifugal clutch to variable-diameter input pulley. Sliding cone on pulley, moved hydraulically, grips V-blocks running on flexible band (inset). Blocks push output pulley, turn shaft.



Stationary version, designed for industrial use, features a hydraulic clutch.

cone diameter decreases. Both changes are proportional, since the drive belt's length remains fixed.

A combination of throttle position, manifold vacuum, and road speed determines transmission ratio. The net result automatically regulates valves that determine oil pressure to the hydraulic cylinders controlling cone spacing.

You can interrupt the transmission's automatic operation—for brisk acceleration or sharp engine

braking—with a selector lever. The lever also engages reverse through auxiliary gearing.

With Transmatic, a simple centrifugal clutch does the job of a fluid coupling—the torque multiplication of a converter isn't needed. Not only does the belt system make possible an extremely low starting ratio and infinitely variable upshifts; there's no creep at idle, and fuel economy should equal that of a manual gearbox. ■

Science takes a new look
at the
Liberty Bell



World's largest industrial radiograph reveals "new cracks"

By SUSAN BRONSON

In its 224 years, Philadelphia's Liberty Bell has been seen and photographed by millions of tourists. But until last fall, no one had ever plumbed the innards of the one-ton bell with the famous flaw.

Then, on the night of November 24-25, scientists were able to look inside the Liberty Bell by means of what is probably the largest radiographic picture ever made on a single sheet of film—seven feet by 52 inches. This picture is shown on the opposite page. If it looks like an X ray, that's not surprising.

A radiograph is an image made when radiation of any kind passes through an object and exposes film behind it, recording the internal structure of the object. The radiation may consist of neutron beams, X rays, or—as in the case of the Liberty Bell—gamma rays. Gamma rays, like X rays, are electromagnetic waves, but they have a shorter wavelength and higher energy, and thus are more penetrating. They were needed to make this picture because of the bell's thickness—three inches at the lip.

The Liberty Bell probe was launched by Ralph E. Turner, an engineer with Eastman Kodak who served as project director. It was carried out under the aegis of the National Park Service.

One reason for undertaking the venture was simply that the bell "had never been radiographed before," Turner explained. The time had long since arrived, he felt, to discover hidden damage from shrink—internal physical contraction produced by fast cooling of metal in a clay mold.

Moving plans

Previous studies had concluded that the national landmark was in no immediate danger. But Bicentennial authorities planned to move the bell from Independence Hall to a spot a block away, more accessible to tourists. Could it stand the strain?

The history of the bell was not encouraging—a legacy of engineering nightmares. Commissioned by the Pennsylvania legislature, the

bell was cast in 1752 by respected British craftsmen. It cracked the first time it was rung. Its makers labelled it "the only bell from Whitechapel's to have so cracked in 400 years." Recast by two Philadelphians, it remained intact when struck, but instead of ringing melodically, it gave out a "bonk." The third casting was successful—as far as the sound. But a large crack appeared in 1835. Patched up, the bell rang for the last time in 1846, when it cracked beyond repair.

Radiography, however, showed that the bell and its interior support structure were sturdy enough to withstand an uprooting, and on December 31 of last year, the Bicentennial-inspired relocation was made.

Bad dreams

Turner said he had had nightmares for weeks—"constant, recurring dreams of working on the bell in front of television cameras, and then having the bell come crashing down in front of us." But his fears were groundless, and the project was carried out as planned.

The radiation source was a projector containing the radioisotope cobalt-60, which continuously emits gamma rays. The source was powerful enough to penetrate nine inches of steel. (The Liberty Bell is mostly copper and tin in about a three-to-one ratio.)

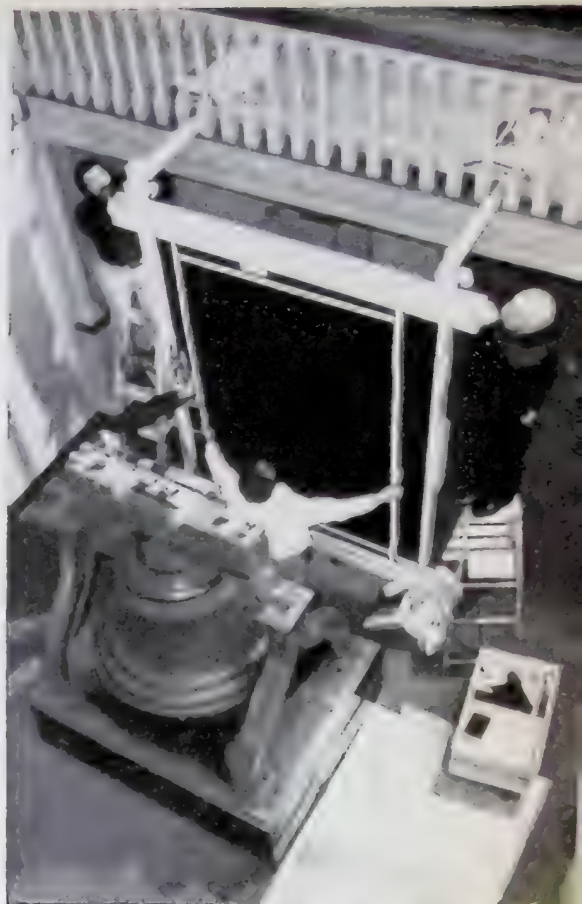
The projector's collimator, a focusing lens, was cast using a technique not found in engineering textbooks. A stainless-steel salad bowl was filled with heated lead. A hole was drilled into the molded half-sphere and presto!—a collimator to fit specifications.

Aiming the projector required the precision of an expert marksman. Distortion would enlarge the 46-inch diameter at the bell's lip, the widest area, by a full two inches. This meant that on a 52-inch-wide film sheet, "we had only two inches on either side to play with," as Turner put it.

The answer: a \$12 telescopic rifle sight equipped with a 45° angle mirror at the eyepiece. This was set on a metal bar that fit into the collimator. The cross hair could then be centered on the bull's-eye taped on the bell.

Six tons of concrete blocks piled up behind the building formed a radiation shield. Turner knew the area was safe because he stood vigil outside the hall, carrying a radiation meter.

The radiographs showed "more detail than expected," said Turner.



A plywood-framed sandwich of 14 radiographic film sheets is set up in Independence Hall. Silver in the film emulsion helped absorb scatter radiation.



Checking the aim of the gamma-ray projector is Ralph E. Turner, project director. The radioactive source was 50 feet away from the Liberty Bell.

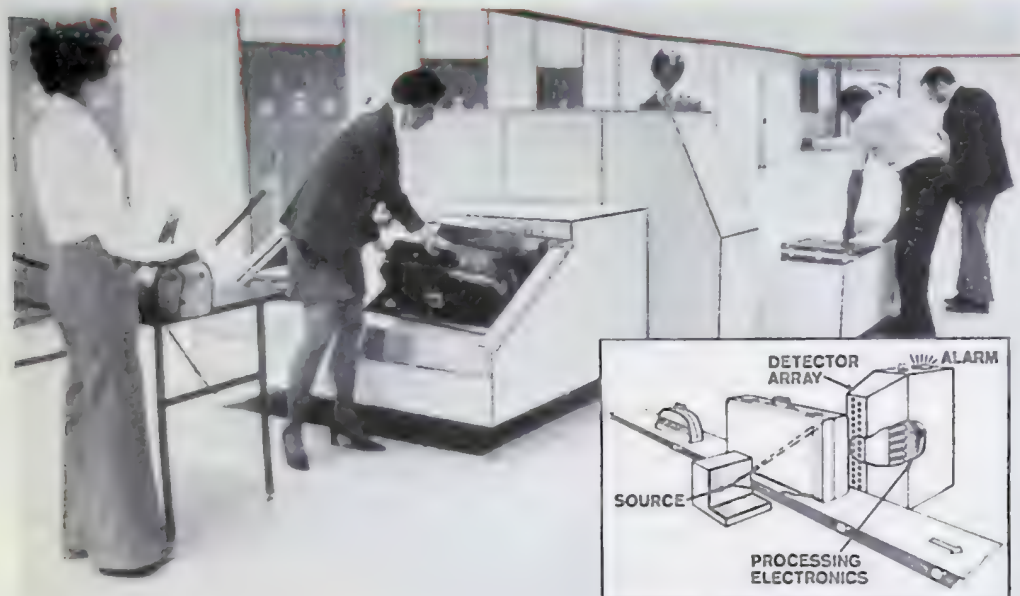
Besides revealing suspected cracks near the top, they uncovered a crack in the bell's clapper.

That should not be a problem, however. Since 1846, the only way anyone has ever rung the Liberty Bell has been very carefully, with a rubber mallet.

Radiographic probe lasting 7½ hours pinpointed the location and extent of the Liberty Bell's hidden cracks.

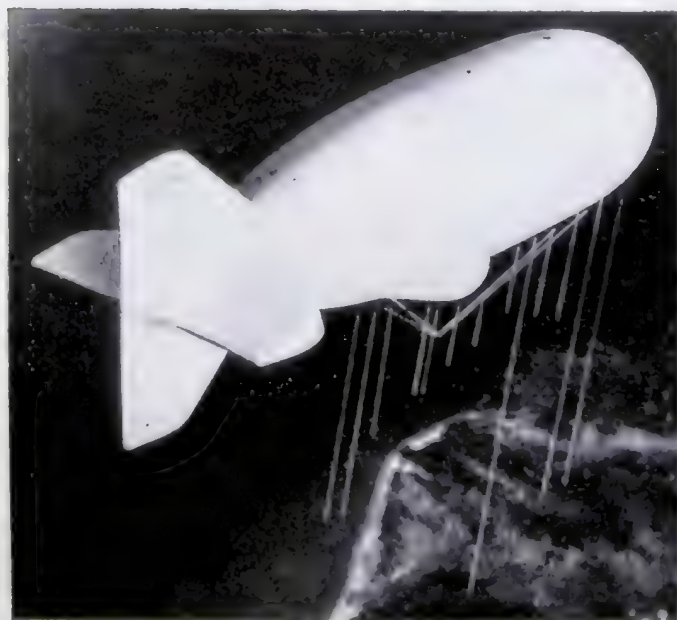
What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS



Automatic baggage checker detects bombs

A computerized scanner to detect weapons and explosives in hand baggage, tested at Washington National Airport, may be the forerunner of faster, more sophisticated models that will screen checked baggage. The demonstration system above, by Westinghouse Research Laboratories, consists of a gamma-ray source mounted to penetrate luggage with two fan-shaped beams (inset). Detector arrays, scanned by a minicomputer, provide a profile—based on density and area—of objects in baggage. Suspicious items sound an alarm.



Crash dash

Designed for small cars, Cal-span Corp.'s experimental passenger dash panel collapses like the steering column on today's cars. In crashes above 15 mph, an air-bag restraint also inflates. A crushable bar protects the passenger's knees.

Aerostats

Tethered at 10,000- to 15,000-ft. altitudes, balloons like this will expand telephone, TV, and radio service in Nigeria. By 1979, TCOM Corp., a Westinghouse subsidiary, will have installed 10 balloons, called Aerostats, to support transmitting and receiving equipment.



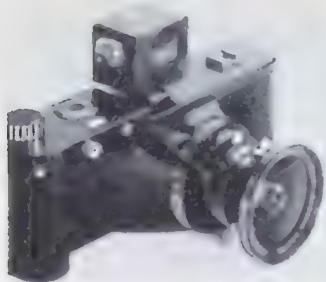
Scissor lift

Push a button and these scissors open to lift up to 1000 lb. Two models of the platform provide work heights of 19 or 25 ft. Batteries supply propulsion and, via inverter, 300 watts of AC power for tools. Patent Scaffolding Co., 2125 Center Ave., Fort Lee, N.J. 07024.



City car

Think small, says European Ford, with this agile little urban car for commuting and shopping. A four-cylinder engine is carried transversely in the squared-off tail, providing room for 2+2 seating up front. The dream car is from Ford's Ghia Design Studio in Turin.

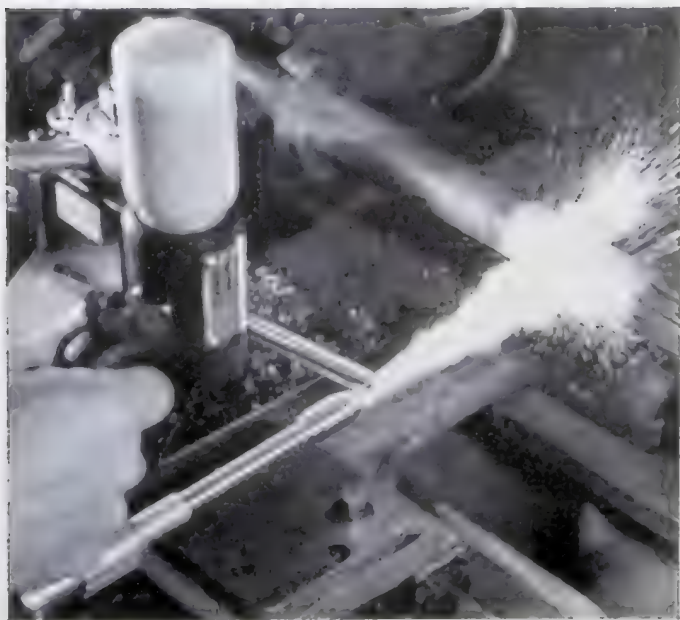
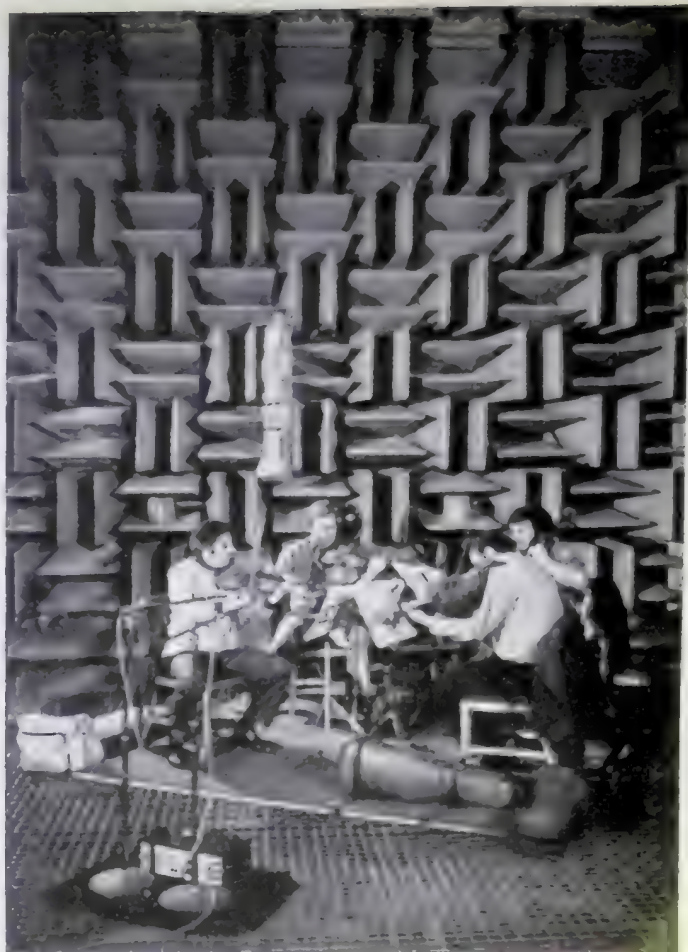


Panorama camera

Need super-wide shots? Linhof's new Technorama camera uses an ultra-wide 90mm lens for a 2 1/4-by-6 3/4-in. film format. You get four shots on a roll of 120 film, eight on 220 film. H. P. Marketing Corp., 98 Commerce Rd., Cedar Grove, N.J. 07009.

Anechoic quartet

Members of the Juilliard String Quartet recently tested old and new music instruments at the National Bureau of Standards' anechoic chamber in Gaithersburg, Md. The chamber absorbs 99 percent of sound above 50 Hz, permitting measurements of an instrument's true properties.



Metallizing kit

Worn metal shafts can be restored with a lathe, oxyacetylene torch, and the Cryotherm Process, says Nassau Research Corp. (400 Cleveland Ave., Highland Park, N.J. 08904). Metal powder in the \$395 kit is sprayed on, and bonds at under-500°F base-metal temperatures.

Rescue boat

Powerboat racers can be rescued faster and safer with the Dell Quay Rescue Boat, says its British manufacturer. An injured person is eased aboard quickly on a hydraulic bow-mounted ramp. It's first lowered below water level, then raised (inset). Time: 15 seconds.



Dent tester

Shoot metal pellets at aluminum panels? Engineers at Reynolds Metals do it to show that such panels need be only slightly thicker than steel to provide equal dent resistance for car bodies. The "gun" fires one-inch metal balls at 20 to 60 mph.

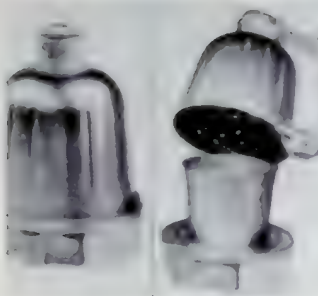


What's New



Blow-up theater

Inflated tubular frames supported by continuous low-pressure air flow make this exhibit tent easy to set up. The plastic theater packs away compactly, sets up fast, and seats 24. Display Sales, 555 Fair Lane, Cincinnati, Ohio 45227.



Portable distiller

Plug in Newater when you need bacteria- and pollutant-free water. Water in the aluminum bucket, evaporated by a Teflon-coated heating element, condenses under the dome and is collected in a bottle. Newater International, Bloomingdale, Ill. 60108.



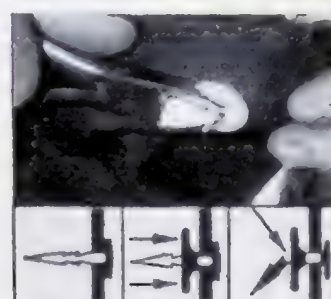
Crash absorber

You won't find these test vehicles at dealers. Minicars, Inc., Goleta, Calif., is making only 25 of the one-ton Research Safety Vehicles under a federal contract. The unitized body is filled with plastic foam to absorb energy in high-speed crashes. A radar/computer warns of "threats."



Water bag

This folding watering "can" saves storage space for city dwellers with balcony or rooftop gardens. The plastic bag holds a gallon, and has a perforated corner as a sprinkler head. Use as a portable shower, too. Chindwell Co., Hyde House, Edgware Rd., London NW9 6JT, England.



Easy filler

Giant hoses connecting a string of railroad tank cars now permit them to be filled and emptied from a single connection. Valves and sensing devices maintain a 3000-gallon-per-minute flow from car to car. General American Transportation Corp., Sharon, Pa., developed the system.

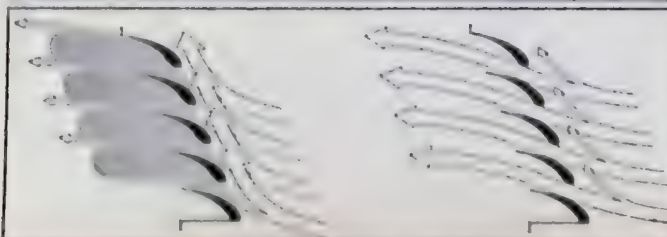
Push-on buttons

Press a plastic pin through a garment, push on a one-hole button, clip off excess pin length. That's how these Belgian quick-fit buttons go on. They come in many sizes and colors for a variety of clothes. Blanchisserie Le Tilleul SA, Rue du Tilleul 105, 1140 Brussels, Belgium.



Airfoil grille vs. high-speed drag

A lamellar grille on this experimental Ford Capri has no moving parts, but effectively closes up at high speeds to act as an air dam. This reduces drag by 12 percent, and also cuts lift by 30 percent. The horizontal slats have an airfoil design, and in traffic or at moderate speeds allow full air flow to the radiator (bottom, right). As speed rises and the mass of ram air increases, boundary-layer effects form air cushions between slats that partially block the intake (bottom, left). The main flow is diverted over the hood, while some still passes through to the radiator. Ford in Germany developed the grille.



Slide-away

Perma-Lock almost looks like part of your bike. Its V-shaped chrome-steel tube holds a vinyl-coated steel cable and key lock to secure both wheels. Price: \$15.95. Maker: Tri-Pod Products, Perma Lock Div., 590 N. York Rd., Bensonville, Ill. 60106.

What's New IN BOATING



Control-handle kit

You can shift gears, change speed, and steer with one hand with this add-on for 5.5- to 25-hp Evinrudes and Johnsons. To shift, press a red button in the end and push or pull the handle; to change speed, twist. \$27.50 for new 9.9- and 15-hp engines, \$24.95 for others.



Crooked Island catboat

Built for commercial lobstering in Bahamian waters, a new Chris-Craft has appealing features for recreational boating as well. She's only 18 ft. 9 in. long, but a 9-ft. 4-in. beam gives her great carrying capacity and a shallow 18-in. draft. The fiberglass hull and liner have foam between for strength and flotation. Inboard power comes from a durable, thrifty 11-hp Renault RC11D diesel. One tank of fuel (3½ gal.) lasts 10 hours; there's an extra five-gal. tank. A live well opens to the sea. \$6500 with tiller steering. Chris-Craft, Pompano Beach, Fla. 33061.



Inflatable kayak

Someone's holding up the bow of this 13-ft. Skato to show how rigid she can be. Her 35-lb. hull—polyester fabric bonded to Hypalon-coated rubber—folds into a 27-by-14½-in. bag. A foot bellows inflates her. \$330. Kiepper America, 35 Union Square W., New York, N.Y.

Pedal boat

Foot-power the molded-plastic Pelican—or you can clamp an electric trolling motor on her bow. Weighing only 115 lb., the 92-by-62-in. craft can be car-topped. A vinyl canopy on a folding aluminum frame is extra. Eakay Plastics, 2566 Boul. Le Caribéen, Chomedey, Lével, Québec.

What's New IN ELECTRONICS



Swinging mount

A thief won't spot your CB antenna with the Stowit bracket—it pivots the antenna inside the trunk when not in use, snaps back up when it's time to put the ears on. Good for the car wash, too. \$9.95. Maker: Holly Enterprises, Box 486, Addison, Tex. 75001.

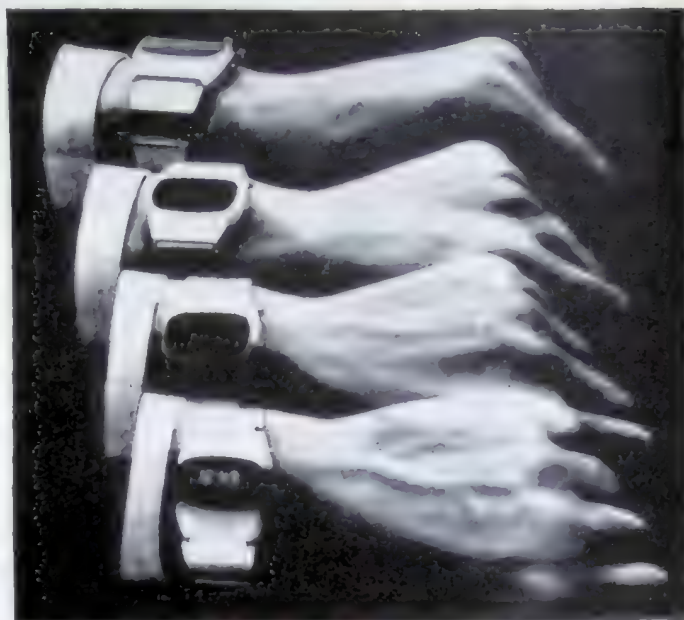


All-in-one

This is the way to keep in touch—anywhere. The Trans Portable has AM/FM/stereo radio, eight-track player, 23-channel CB rig, and 25-watt, 12-channel marine radio-telephone with weather band. Price: \$950. Trans-Comm, 8805 Bond St., Overland Park, Kan. 66214.

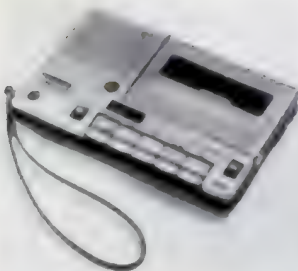
Wrist twist

Here's a new LED digital watch from Gruen that's not a two-hander. Instead of having to push a button for the time, just flick your wrist—a sensor detects the movement, turning on the display. Added button gives seconds, month, and day. Flick-It is \$250.



Tiny taper

The new Sony TC-150 is just a handful of tape recorder—it measures 1-3/16 by 4 1/2 by 6 7/8 inches—but uses a standard cassette and has a frequency response of 90Hz to 10kHz. A new motion sensor provides automatic stop at tape end. Price: \$190.



Substitutor

Designing or checking an electronic circuit? Ohmranger is a resistor substitution box that adds increments up to 10 megohms in one-ohm steps. All resistors are half-watt, at one-percent tolerance. It's \$58. Ohmite Mfg. Co., 3860 Howard St., Skokie, Ill. 60076.

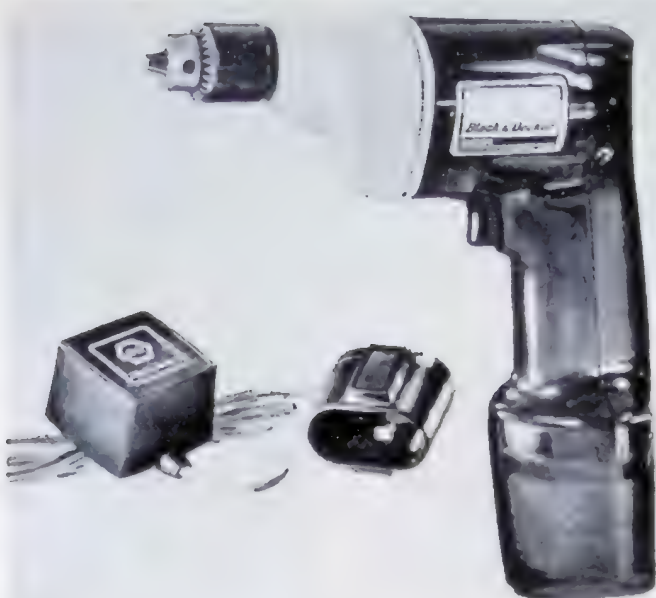
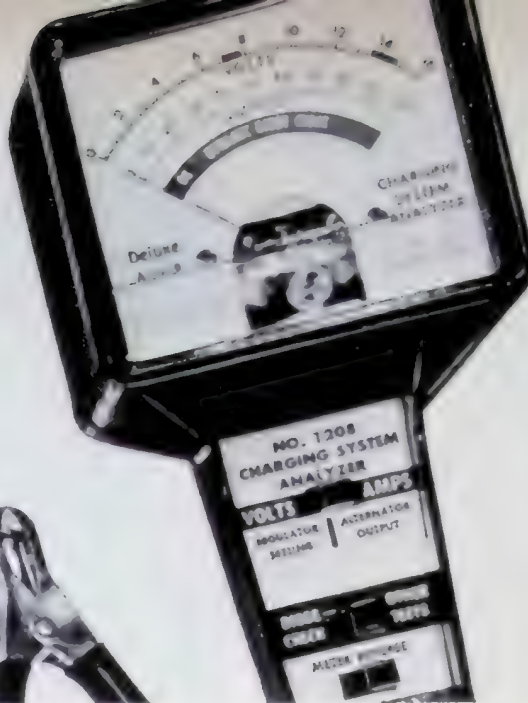
CB stand

If things are too tight under the dash for your new CB radio, try this CB caddy—it mounts on the transmission hump, holding the rig out of the way of the dash. Inside, a four-inch speaker aims the audio at you. \$24.95. Falcon Enterprises, 3960 S. Marginal Rd., Cleveland, O. 44114.

What's New FOR YOUR CAR

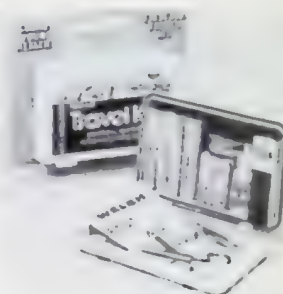
Volt-amp tester

Want to check out your car's charging system fast? Milton's 1208 tester lets you do it. It functions as a conventional volt-amp tester, and also makes a quick check to pinpoint problems in alternator or regulator. Milton Industries, Inc., 4500 W. Cortland St., Chicago, Ill. 60639.



Heavy-duty cordless

Tough jobs need heavy-duty cordless drills, says Black & Decker, which has introduced two for the auto after-market: a 1/4" drill with self-contained power cell and a 3/8" unit with removable power pack. Both can be recharged in 16 hours.



First-aid kit

Moistureproof and dustproof, the Welshgard plastic case is designed to protect its contents on the road: bandages, tapes, scissors, forceps, booklet, and other first-aid items. Carrying handle doubles as wall hanger. The kit is \$14.69 in stores. Welsh Div., Cranston, R.I. 02920.



Wiper brain

Fine mist falling, causing your wipers to streak at normal speeds? You can adjust the delay between sweeps with Heathkit's windshield-wiper delay. It offers between-sweep time adjustments from five to 30 seconds. \$14.95. Heath Co., Benton Harbor, Mich. 49022.



Carb wrench

Removing a fuel-filter nut, and two normal wrenches won't fit? Thexton's thin Carburetor Nut Wrench solves the problem. It allows you to use two wrenches side by side. Thexton Mfg. Co., 7019 Oxford St., Minneapolis, Minn. 55426.



Hose disconnect

If you disconnect your radiator hoses often, as race drivers do, this quick-disconnect makes the job easier. Set includes cadmium-plated connectors and rubber O-ring. A quick twist separates the hoses. It's from Moroso Performance Sales, 737 Canal St., Stamford, Conn. 06902.



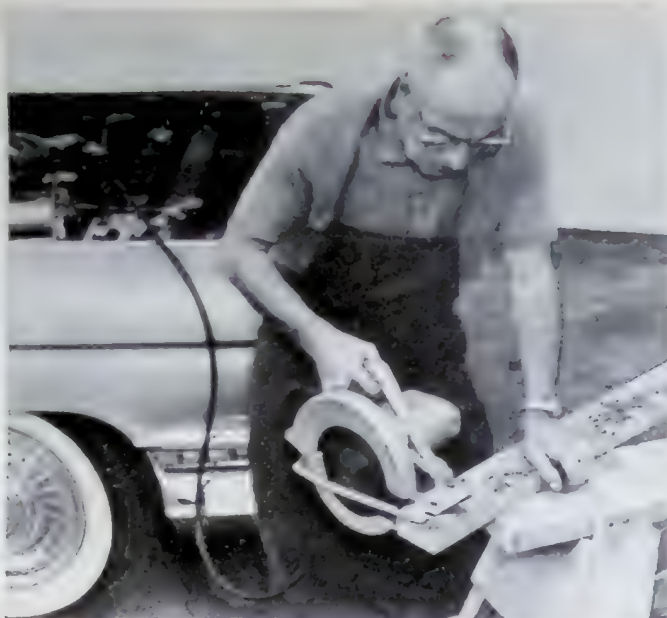
Oil filter

The Motor Guard filter does a better job than conventional oil filters, says the maker, because it forces oil to pass between (instead of through) layers of the element for the length of the roll, to better trap contaminants. Motor Guard Corp., Box 1884, San Leandro, Calif. 94677.

What's New IN TOOLS

Portable power

Hook up Little Mule to your car, and 3300 watts of 110 VAC are at your disposal. Kit includes alternator powered by vehicle's fan belt, two outlets, on-off switch, voltmeter, mounting hardware. Little Mule is \$249.50 from Redi-Power, 930 Thompson Pl., Sunnyvale, Calif. 94086.



Light 'n tweeze

Put the squeeze on things in dark nooks and crannies with Tweezer-Lite, a tweezer with built-in light and battery. It's available with beveled edge, square edge, or points, for \$9.95. Tweezer-Lite, 5911 Towne Ave., Los Angeles, Calif. 90003.



Pipe wrenches

Got a pipe to wrench? Try one of Ritco's new pipe wrenches, designed for the home handyperson. Four sizes are offered: 8" (\$4.40), 10" (\$6.70), 14" (\$8.80), and 18" (\$12.75). Ritco Div., Ridge Tool Co., 400 Clark St., Elyria, Ohio 44035.



Hedge trimmer

Thought you'd seen all the attachments for portable electric drills? Now there's Hedge Trimmer, with a 14" long blade. The attachment fits any electric drill and costs \$8.63. From Arco Products Corp., 110 W. Sheffield Ave., Englewood, N.J. 07631.



Executive tool case

Attache-case styling belies the contents of this polyethylene tool case. A lift-out pallet (both sides shown) organizes the tools. Case measures 15 1/2" by 12 1/4" by 4 3/4". Price, including organizer, is \$27.75. Platt Luggage, 2301 S. Prairie Ave., Chicago, Ill. 60616.

Holdup

Need a helping hand on an electronics project? GE's Xtra Hands has two alligator-spring clips that adjust via six ball joints to hold work firmly. A heavy base prevents tipping, and can be clamped to a bench or held in a vise. It's \$8.95 at GE tube dealers.

What's New

IN HOME IMPROVEMENT



Long-life light

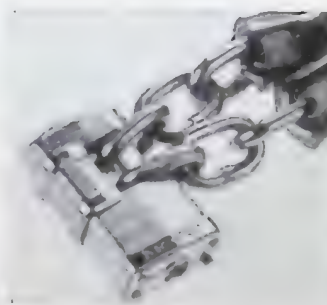
Screw this self-ballasted mercury-vapor lamp into a standard socket; an incandescent filament inside replaces external ballast. The 160-watt bulb delivers 2200 lumens and has, says Westinghouse, an average life of 16,000 hours.

Double doors

Grille-front doors on both sides of this suspended kitchen cabinet give you two-way access, as well as a see-through effect. Made by Long Bell (Box 8411, Portland, Ore. 97207), the cabinets are ideal as a room divider between kitchen and dining areas.

Extinguisher

Any fire—whether it involves wood, paper, fabric, plastic, rubber, greases, oils, gases, solvents, or electricity—can be doused with this fire extinguisher, says the maker, Walter Kidde & Co., 675 Main St., Belleville, N.J. 07109. Price: \$18.



Tough lock

A bolt cutter can't slice through Armorlock's shackle, says Master Lock Co. (2600 N. 32 St., Milwaukee, Wis. 53210), because the lock's too thick to fit into the bolt-cutter's jaws. It's also got a revolving shackle guard to frustrate sawing. Armorlock (Master #37) costs \$5.95.

Redwood panels

What can you do with a redwood panel up to three feet wide, four to 32 feet long, and $\frac{3}{4}$ to two inches thick? Build cabinets or shelving, panel a room, side a house, or fence in the backyard. Made by Louisiana-Pacific, 1300 S.W. Fifth Ave., Portland, Ore. 97201.

Portable coolth

Sears' new Cool 'n Lite air conditioners feature easy portability: They're center-balanced and weigh 43 (4000 Btuh), 49 (5000 Btuh), and 55 (6000 Btuh) pounds. EER's: 5.4, 6.3, and 7.0; prices: \$140, \$170, and \$200.



New CB rigs

from new CB makers

By WILLIAM J. HAWKINS

If you've heard we're in the midst of a CB explosion, get ready—it's only a rifle shot compared to the war that's about to begin.

Veteran CB makers are well entrenched, but they now face some big guns in the electronics industry

that have been rolling since the beginning of the year. General Electric, Motorola, Sharp, Hitachi, to name a few, have just introduced new lines of citizens-band transceivers.

Other big makers are returning: Two are RCA and Eico, which deserted the field after an earlier try

some years ago. Some new makers have been allied with the receiver market for a long time: Shakespeare and Channel Master are well-established antenna manufacturers. And, of course, giant retailers like Sears and J. C. Penney are in the battle.

Here are the latest from some of the biggest. 45

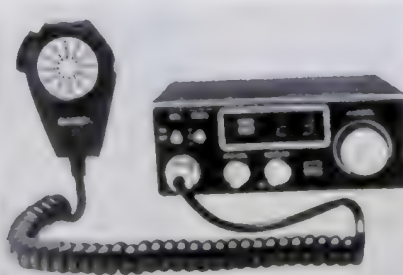


Shakespeare GBS 2000 is one of four new models being offered for mobile use. It has 23-channel selector, PA, switchable noise limiter, and an obvious-

ly large S/RF meter. It's \$159.95, with other mobile models beginning at \$139.95 and working up to a single-sideband unit for \$385.

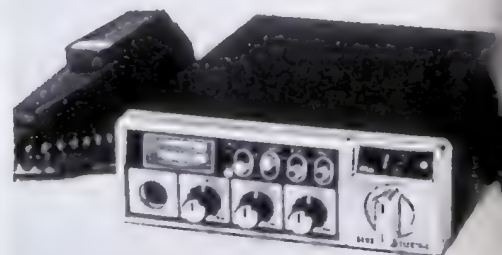


Sears model 36771 has 23 AM channels plus 46 SSB. Clarifier line-tunes rig (necessary for SSB). Unit has switchable noise limiter with PA system, and is operable on either 12VDC or 115VAC for base operation. \$299.95. Other two models from Sears, 3671 for \$99.95 and 3674, \$149.95, are standard AM units.

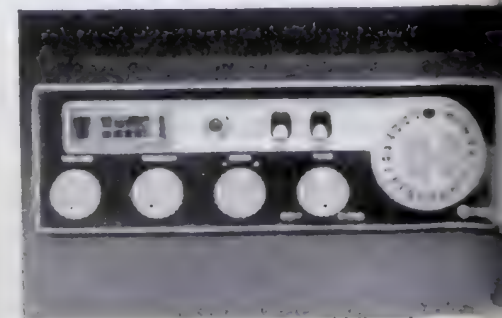


Sharp CB 800 mobile rig has digital LED display for channel indication. It also includes delta tune, PA, and switchable noise limiter. \$149.95. Second available unit in line, model CB 700, costs \$119.95. It uses a standard mechanical channel readout, has built-in noise limiter and delta tune switch.

New sets from makers who



GE 5820 has priority channel with indicator, switchable noise limiter with blanking, and digital channel readout. At \$220, it's the top end of three mobile



Hitachi 2425-H is the top of its mobile line at \$169.95; two other models are available from \$114.95. It has switchable noise limiter/blanker, PA, and



Channel Master CB 6832 uses a phase-lock loop circuit to determine any one of its 23 operable channels. Front switches actuate noise limiter, variable PA, and delta tune. Mobile rig is \$179.95. Second model is CB 6830 for \$159.95—similar, but without switchable noise limiter and delta tune.



Eico model 7723 marks its reentry into the CB market. This 23-channel unit has built-in noise limiter, S/R meter, squelch, and PA, for \$139.95. Designed for $\pm 12\text{VDC}$. Available accessories include amplified microphone, and receiver amplifier to be attached between rig and antenna.



Motorola Mocat 2020, \$229.95, uses digital readout for channel display with switch to control intensity. Has switchable noise blanker (they call it extender) and PA. Accessory AC base and desk mike are available. Other models are: 2000 at \$179.95, 2005 at \$214.95, and 2010 at \$199.95.

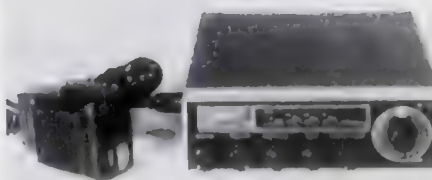


RCA Co-Pilot 14T200 is one of two new mobile rigs designed for $\pm 12\text{VDC}$. It has S/R meter, delta tune, PA, LED modulation indicator, and switchable noise limiter. \$169.95. Low-cost version, model 14T100, at \$134.95, is available without delta tune and switchable noise limiter (built in).

build base and in-dash models, as well as mobile units



models beginning at \$130. A base unit, model 5870, is available for \$240, and is operable on 115VAC, or 12VDC for possible mobile use.



J.C. Penney 6217 has separate volume control on mike for modulation level. It features antenna trouble-warning light and noise-blanker control. It's \$159.95—



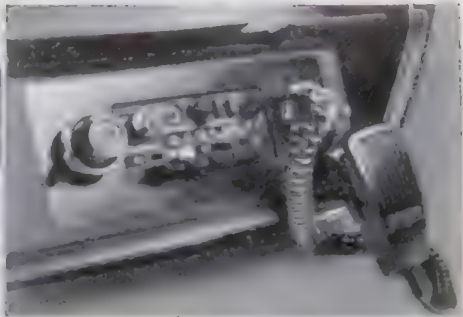
one of four new mobile rigs from \$99.95 to \$179.95. Model 6236 (\$169.95) is one of three new base/mobile combos (SSB unit is \$319.95) available soon.



S/R meter. Base model 4800-H (\$189.95) works on AC or DC voltage, all 23 channels. Other base available is SSB rig model 6600-H, for \$329.95.



Panasonic under-dash unit has quick-release brackets for removal when not in use. Model RJ-3200 has noise limiter, blanker, 23-channel control, for



\$179.95. For in-dash mounting, CR-B1717 has four-way adjustable shafts. CB calls come in while you listen to music on built-in AM/FM radio. \$200.



Car racks for the gear that won't go inside

Bulky cargo can now ride atop your car safely, if you use the right rack

By JIM ELDER

Automobiles are shrinking. But the bikes, boats, skis, surfboards, ladders, luggage, tents, sleeping bags, and cooler chests you carry in and on your car are as bulky as ever. Solution: a rack for those items that won't go inside.

Some racks are multipurpose. Others carry specific things—skis, kayaks, bikes, even fishing rods. Pick a rack based on the features you need and its price. With few exceptions, brand is not significant. A handful of manufacturers make most luggage and boat racks, and sell them under their own or other brands, and even unbranded. Prices, I have found, vary as much as 100 percent among identical racks sold under different labels.

Basic boat and luggage cross-bar sets start at \$15 and range to \$40 for extra-wide two-canoe mod-

els. Mark Fore makes many of these. Others are available from Grumman and other distributors.

Bicycle racks offer an even greater price spread: from \$6 to \$60, with most bumper-mount models in the \$15-25 area. Again, virtually the same racks can be found under many brand names.

Ski racks are now made by only a few major manufacturers. It could cost you as little as \$8 to mount two pairs of skis on a Beetle and up to \$40 to "lock" the same two pairs on a rack custom-designed for a limited-sale car. Conventional sedan-roof racks range from \$15 to \$40.

Handy foam blocks for cushioning cartop boats and canoes cost about \$15. Add several dollars for bow and stern bumper tie-downs. Hitch-post loaders will cost from \$35 to \$50, and a roller bar for boat racks begins at \$10.

Finally, my favorite basic luggage-boat-canoe-ski-plywood-and-everything rack, the Quick-N-Easy, sells for \$26.

Whichever rack you select, choose

the tie-down system carefully. Screw-tightened padded-steel straps are usually more secure than web-and-buckle types. Rubber tension devices should be avoided. Never depend on suction cups to hold a rack to the car roof.

Gutter strength

How much of a load will the rain gutter of your car support? Car manufacturers give little information. Good advice: Avoid securing racks to any gutter attached with spot welds, clips, or glue. Best are drip rails formed from an extension of the body metal.

Most cars can safely carry 200 pounds on racks supported by strong gutters or properly placed pads. Over 200 pounds is a structural gamble and a potential handling hazard.

Many new-car buyers get factory- or dealer-installed roof racks. Unfortunately, many of these are more frill than function, it seems to me. They're often flimsy, lack tie-down points, offer little roof protection, and sometimes have



Simple VW rack has six contact points, requires only two strong hold-down clamps. It is strong enough to stand on. Price is \$35.75, and it's sold by VW dealers.



Ski rack that's kind to cars with vinyl roofs is Barrecrafters SR-91. It locks with one downstroke that squeezes padded clamps together. Barrecrafters, Box 158, Shelburne, Vt.

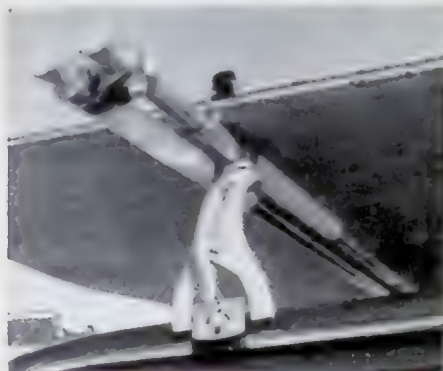


Bike Porter fits some trunks and hatchbacks, and all roofs. It puts bikes above bumper-crunch hazards. Schwinn, 3701 W. Cortland Ave., Chicago. Price: \$40.

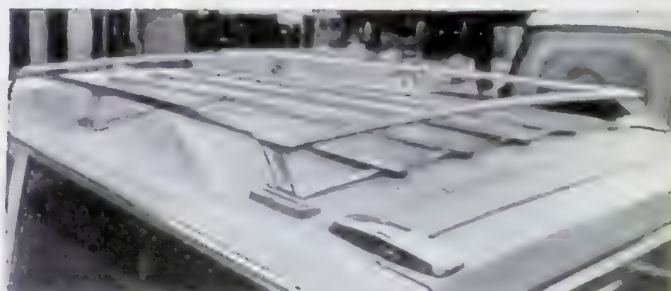
Trunk/hatchback ski rack carries four pairs of skis and poles. A&T 152 LK has padded-steel attaching straps. A&T Ski, Box 88277, Seattle, Wash. 98188. \$35.



Cam-lock clamp secures Universal carrier to gutter without tools. Roller-bar loading aid is shown here. Quick-N-Easy, 934 W. Goothill Blvd., Monrovia, Calif.



Ski posts and rubber straps from A&T turn Quick-N-Easy into a ski rack. Hanging underneath is a Q-N-E gunwale clamp that lets you carry canoes, pipe, ladders, and lumber.



Factory-installed racks are often fragile. This Volvo rack has cushioned roof strips, and is better than most. It's adequate for luggage and skis, but not for a canoe.

crossbars that would collapse under a light canoe.

What about enclosed racks? They're handy for protecting gear such as sleeping bags from the weather. But these add wind resistance to your vehicle, even when you aren't carrying cargo. All racks add some air resistance and lower gas mileage. With some cars, passing acceleration can be affected.

Rack placement and weight also affect performance. Keep the loads as light and trim as possible. Experiment with placement if your

roof is long enough, and become familiar with handling changes.

Trunk carriers

Trunk racks are second in popularity to roof racks. They come in suction-cup and strap designs, as well as permanent bolt-ons.

Ski racks on trunks usually prevent opening, although some sloping hatchbacks can be lifted. Crossways trunk ski racks can be hazardous to both skis and pedestrians.

Bumper racks are popular for bikes, even though the bikes are

dangerously exposed to parallel-parking crunches. Many bike bumper racks prevent access to the trunk, also.

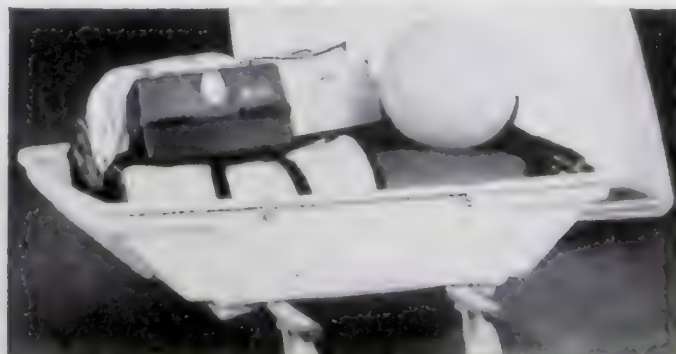
One of the best bike carriers is from Schwinn. It attaches securely to a bumper of almost any shape, then detaches for storage or trunk access, leaving the bumper mounting bars attached for quick re-mounting. All "whistle holes" are plugged, it is heavily plated, and the cycle hangers are cushioned.

Several manufacturers market

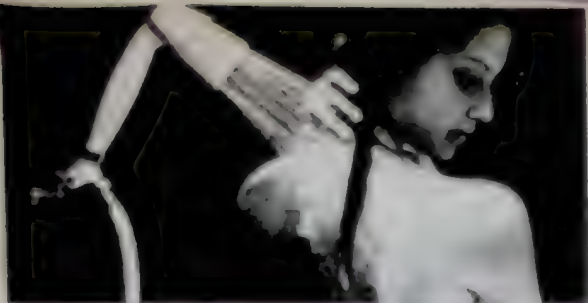
[Continued on page 115]



Foam blocks from Grumman slip over wooden gunwales of canoes or kayaks. The craft is then turned upside down and carried on the car roof. Foam prevents paint damage.



Enclosed luggage carrier from Sears holds 16 cubic feet. The X-Cargo carrier is made of molded polyethylene. Roof model is \$50 from Sears stores, or through catalog.



You get a choice of regular spray (top) or pulsing massage action (below) with shower massagers like this Bowles Fluidics' Aqua Massage shower head. Hand-held unit comes with wall-mount.



It's good clean fun with coarse to fine sprays, rinses, aerated streams, plus pulsing or vibrating massages

By RICHARD STEPLER

Can the massaging effect of pulsating jets of water soothe your tired, aching muscles? Yes, say the makers of the new massage-action shower heads. And I agree. My general impression after trying them is that they're a big improvement over standard shower heads.

I especially like the adjustable sprays, from fine to coarse, on some models. Others feature "rinse" modes—thick sheets of water that are handy for shampooing. One

Three nozzles in one head is feature of Body Shaper by Chicago Specialty. Spray pattern is "body shaped," says maker. Center nozzle gives massage.

Shower massagers

—new rub for your tub

(photo at left) has three nozzles in one shower head. It really gets you wet fast. Another—Conair's—has body and scalp brush attachments for added stimulation. And one—the Daisy hand-held shower head—comes in colors: red, yellow, brown, and white.

Misty to macho

The massage actions of the shower heads vary: Some spatter water in seemingly random bursts. Others pulse regular "slugs" of water from special nozzles. Still others swirl water in a rotary pattern. The strength of the massage effect also varies. Some of the massagers deliver a vigorous, stimulating massage; others produce a soothing, restful effect. All operate on normal water pressure.

I found the massage effects agreeable and stimulating, a refreshing change from ordinary shower sprays. I preferred the effect of some of the units to others, but this is a



Shower massagers, from left: Bowles Fluidics' Aqua-Vibrator and Aqua Massage shower-head and hand held model;

etc.; Conair's Waterfingers hand-held model with scalp and body brushes above; Teledyne Aqua Tec's hand-held

and shower-head models; Rain Jet and (below it) Chicago Specialty; Interbath's Daisy hand-held unit; Stanadyne's

matter of personal choice. Some shower heads offer other features as well as a massage (see photo captions); you'll want to consider those, too. Many—but not all—come in both hand-held and regular shower-head models. The hand-held models all feature a mounting attachment to hang them from the wall for stationary use. (See the photograph below for a model-by-model rundown.)

Most of the shower massagers operate in three modes: regular shower, massage, or combination shower/massage. You choose the mode by turning a lever, or twisting the shower head itself.

How to choose

The best advice I can offer on how to decide which shower massager is for you: Try as many different models as you can before you choose one. Many stores feature displays with the heads connected to a water supply inside a plastic enclosure; you insert your hand to feel what the spray is like. Adjust the spray patterns on all of them and you'll probably find some more to your liking than others.

Retail prices of the shower massagers range from \$15 to \$40; they're widely offered at discounts, however.

Manufacturers' addresses:

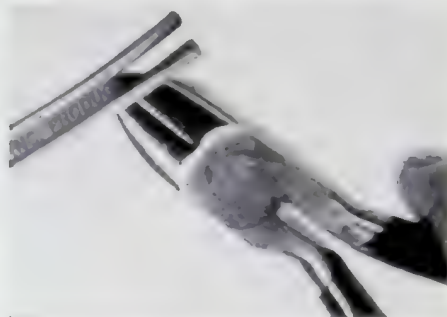
Alsons Corp., E. Chicago Rd., Somerset, Mich. 49281; Bowles Fluidics Corp., 9347 Fraser Ave., Silver Spring, Md. 20910; Chicago Specialty, 7500 Linder Ave., Skokie, Ill. 60076; Conair, 11 Executive Ave., Edison, N.J. 08817; Interbath, 3231 N. Durfee Ave., El Monte, Calif. 91732; Jaclo, Inc., 162 Carlton Ave., Brooklyn, N.Y. 11205; Pollenex (Associated Mills), 209 S. Jefferson St., Chicago, Ill. 60606; Rain Jet Corp., 301 S. Flower St., Burbank, Calif. 91503; Stanadyne, 377 Woodland Ave., Elyria, Ohio 44035; Teledyne Aqua Tec, 1730 E. Prospect St., Fort Collins, Colo. 80521.



Touch Control models; Jaclo's Shower-all Massagers; Alsons' and Pollenex hand-held and wall-mounted showers.



RV plumbing is protected by Frostex heat tape—just plug it in to prevent freezing. Tape should be secured every linear foot with fiberglass tape. To strip Frostex, cut through tape along each conductor with diagonal cutters (below). Then remove center tab of core material and outside layers of insulation.



Parts from FCT-3 kit (upper left) join material to junction box and cap end.

Shrink tubing from FCT-5 kit (right) lets you make Y's, butt splices (bottom).

Antifreeze tape gets hot when it's cold

Heat tapes that will prevent freezing of exposed faucets and water lines buried above frost line are widely available [see PS, Apr. '74]. But all involve certain problems: With most you must be careful not to overlap the tape, thereby creating a hot spot that can burn it out. You need a thermostat for safety reasons. And the length you see is the length you get since the tape can't be cut or spliced. If it's too short, you get an unprotected area; if it's too long, you must double back, increasing the possibility of overlapping.

Now there's a heat tape that:

- Can be cut to any length.
- Can be put to work merely by installing a plug on one end and an insulating cap on the other.
- Can be overlapped, "Teed" or spliced, plus wrapped around empty plastic pipe.

• Has a resistance close to infinity and consumes negligible current at high temperatures. As it becomes colder, however, the tape's heat output increases correspondingly—but only at the spot that's colder. Thus it doesn't need a thermostat.

The material, called Frostex, was developed for the refrigeration industry to wrap condensate lines in air conditioners and freezers. It's available from commercial refrigeration suppliers. Price is about \$2.50 to \$3 a foot.

If you're unable to find it, write to Chemelex, 837 Second Ave., Redwood City, Calif. 94063, for the address of the nearest dealer. Frostex RS1 handles 120 VAC with a maximum length of 100 feet; RS2 takes 240 VAC and has a maximum circuit length of 200 feet.—Evan Powell

Alvin dives 12,000 feet to look through a window into Earth



Over the past decade or so, our picture of the Earth has undergone a total upheaval. Geologists now believe that the planet's surface is not rigid, but in constant motion, with the continents themselves riding along on huge chunks of the outer crust called tectonic plates—though much evidence was circumstantial. Early this year, an expedition used the research sub Alvin to provide science with direct evidence—the first documented series of samples wrenched from the deep layers of the oceanic crust. We sent reporter Robert Gannon along on the trip. He's seen at left, with Chief Scientist Robert Ballard, boarding the Alvin. Here is his report.—Arthur Fisher, Group Editor, Science and Engineering

By ROBERT GANNON

"GUATEMALA, FEB. 4, 1976—A MAJOR EARTHQUAKE STRUCK THIS CITY OF A MILLION PEOPLE AND NEARBY AREAS TODAY, KILLING MORE THAN 20,000, ACCORDING TO A GOVERNMENT STATEMENT." (From *The New York Times*.)

Later that morning, 600 miles northeast along the same fault line, an odd-looking submarine named Alvin was being lowered between the two pontoons of the catamaran Lulu. The wind had risen, and the sub bobbed in the waves like a manatee. Eight men, hauling on lines and soaked with seawater, strained to back the sub out from between the pontoons. Two divers, in the water, were ready to release the lines when the sub was clear.

Inside the 6½-foot, titanium-alloy ball of a cabin, the pilot and two scientists wait amidst the welter of handles and struts, levers, and instruments.

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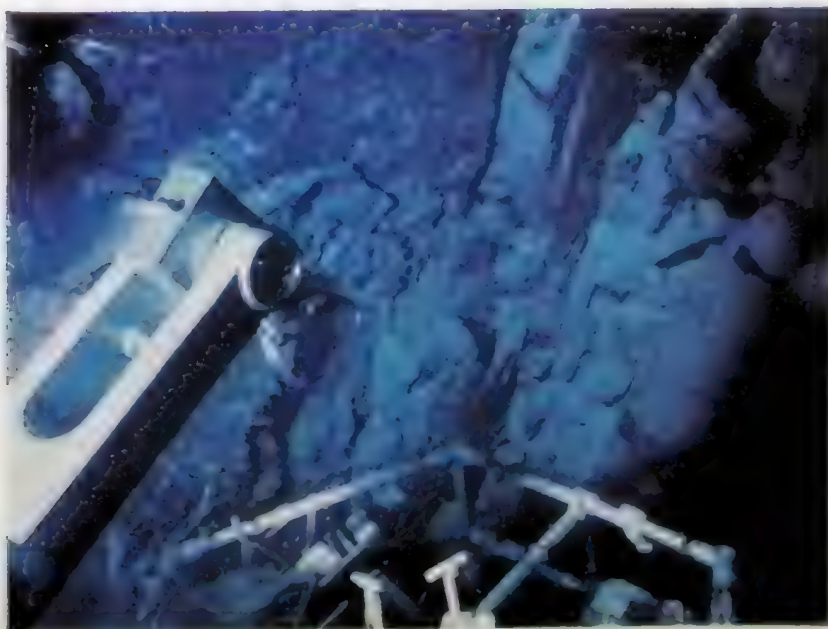
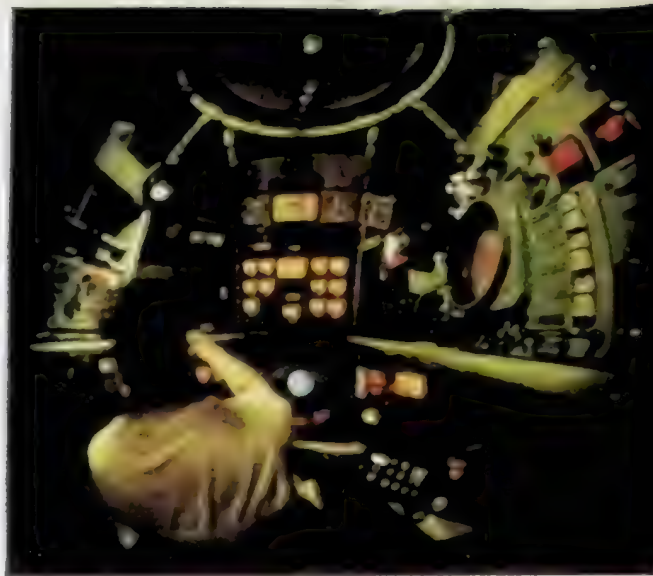
The temperature climbs—89, 90, 94—and Dr. Robert Ballard, 34, geophysicist, strips off his seven-pocket mountaineering jacket and waits for the hatch to close. "This period, this ten minutes or so we're on the surface . . . Alvin is most vulnerable here, and your emotions say, 'Come on, let's go; let's dive now.' But you can't rush; your life is involved—so you learn to relax."

Finally the hatch closes. The pilot, Val Wilson, requests permission to dive, and the sub starts to

Continued



Cayman Trough (arrow) in floor of Atlantic is giant split in earth's crust. Rock scarp on one side towers 6000 feet. ©1968, National Geographic Society.



Deep-submergence research vehicle *Alvin*, shown in these photos, has been operated by the Woods Hole Oceanographic Institution since 1964 for oceanographic study. She is 23 feet long, with an eight-foot beam, and displaces 15 tons. A four-inch-thick titanium-alloy hull permits dives to 12,000 feet. There is room inside the pressure sphere (above, right) for a pilot and two observers, together with scientific equipment and life-support systems that provide for dives of 72 hours if necessary. Four viewing ports provide visibility ahead of and beneath the *Alvin*. The vehicle is driven by three propellers, whose ability to tilt and reverse provides thrust up or down, ahead or astern. Depending on its mission, *Alvin* is equipped with a variety of control, navigation, and scientific instruments, including echo sounder, sonar, closed-circuit TV, underwater cameras and lights, remote manipulators, and so on. Photo at left, taken from *Alvin* near base of 6000-foot scarp in Cayman Trough, shows sub's mechanical arm and sample tray. (Photos courtesy Woods Hole Oceanographic Institution.)

sink. Through the saucer-sized ports, Ballard watches *Lulu's* three propellers begin to whirl, and the shadow that is *Lulu* moves off. A diver's legs pedal past one port, then disappear in a flood of bubbles. The Caribbean water darkens from azure to midnight blue, then at 600 meters, to black.

Alvin is embarked on a signal scientific endeavor. With the support of the National Science Foundation, the U.S. Navy, and the National Oceanic and Atmospheric Administration, and with the participation of scientists from the Woods Hole Oceanographic Institution, Scripps Institution of Oceanography, and other organizations, the sub will attempt a close-up look at the geology of the deep ocean, the first ever to be carried out in a recognizable, identifiable sequence.

For centuries, geologists with picks, maps, and notebooks have been poking about the earth's mountains and valleys, endlessly cataloging rocks, trying to unravel the globe's history. But the fact is, until a dozen years ago the state of earth sciences was comparable to that of medicine before the discovery of bacteria.

Today geoscientists find themselves in the midst of the most rapid revolution in the history of science. It centers around the old theory of continental drift, now going by the name *plate tectonics*. Instead of a nearly inert ball spinning through space with miscellaneous fixed features scattered willy-nilly across its surface, the earth suddenly has emerged orderly and virtually alive.

"It isn't just a big lump of dirt,"

says Ballard. "It's living—dynamic, constantly changing, expressing itself." The earth has revealed itself to be a complex series of interdependent, ever-moving parts, with forces of such magnitude that earthquakes and volcanoes, in the eyes of time, are only flashy curlicues. The crux of the revolution is this: The earth's surface—its lithosphere—is composed of many huge plates, like ice floes on a river. They're in continuous motion—thrusting up, grinding past one another, diving deep into the earth, with the continents borne on their backs.

Scientists across the world are trying to nail down what really is going on, what has happened in the past, what *will* happen. This February, a group from the Woods Hole Oceanographic Institution explored the Cayman Trough, a rift in the earth more than three times as deep as the Grand Canyon, some 75 miles south of Grand Cayman Island in the West Indies. Scientific director of the project: Bob Ballard.

The submarine continues to sink, sliding down the water in a slow spiral, her rear propeller gently pushing. The hull, two inches thick, cools and begins to sweat. Sitting cross-legged on the wood-grate floor, Ballard begins to relax. Might as well; the descent to 12,000 feet takes two hours, and he has little to do.

Jeff Fox, the other geophysicist aboard, asks for a chart of the bottom. Ballard passes it, then returns to watch tiny lights of sea life flit upward past his port. He flips on an outside lamp, hoping to glimpse the sources. But all he can see is a reverse snowfall of specks.

Suddenly a voice crisps through the sphere: "Okay, *Alvin*, you've just passed 1000 meters." The voice is that of Jelle Deboer, aboard *Lulu*. "If you head 53 degrees for 42 minutes you should be right on target."

"Fine," replies the pilot. "Will do." Ballard checks his notes.

As *Alvin* continued its plummet, another Woods Hole oceanographic vessel, the *Knorr*, was steering a "Z" pattern over a part of the trench 23 miles to the southwest, gathering data for *Alvin's* next series of dives. Ordinarily, she works around the clock—mapping the bottom, dredging for samples, measuring heat flow, listening for earthquakes, photographing the terrain two miles beneath her. This day, February 4, was no exception.

Petrologist Wilfred B. Bryan has been up since just before dawn. It's his job today to coordinate the bottom photography and dredging operations. But now he stands at the fantail watching the sun bulging up through the horizon.

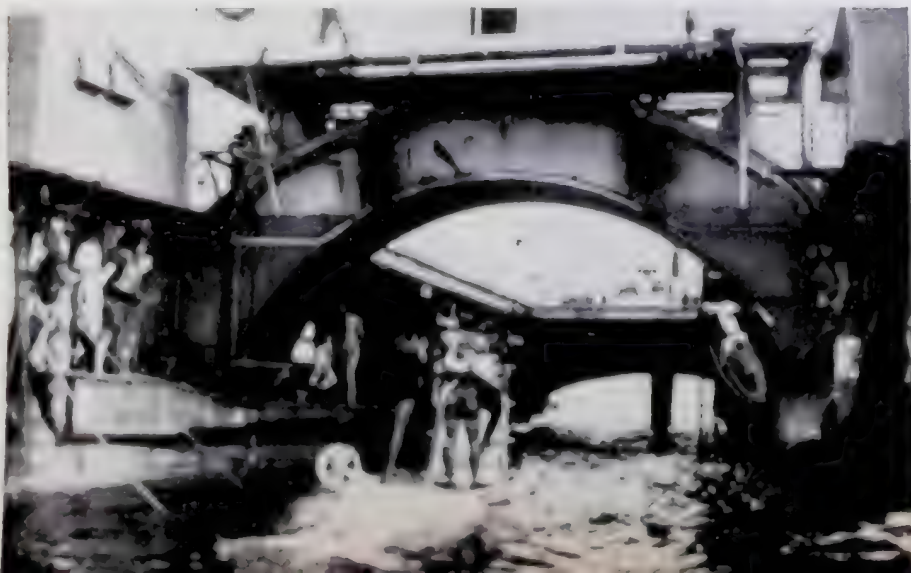
He fiddles with the fold-up magnifying glass dangling from his neck, and sighs. "Everything is going along fine, now," he says, "but oh, God, the trouble we had on our first runs, a week ago—the proof of Murphy's Law, I guess."

"Hey, Bill, cameras are ready," someone yells, and Bryan hurries to check them out—two Edgertons loaded with high-speed Ektachrome. Bryan tests the strobes, switches on the timer, and watches as crane operator Jerry Kotter lowers the frame off the stern and begins to play out line.

Five minutes later, with the cameras dangling 400 meters below the

Catamaran *Lulu* serves as *Alvin's* mother ship, with ability to lift sub out of water (below). Front view of *Alvin* (right,

courtesy National Geographic Society), shows pilot's viewport, mechanical arm, and tray for bringing samples to surface.



Viewing lights are mounted at top of sail; a TV camera and its light are mounted on platform below sail.



surface, Bryan signals for the cable reel to stop. The crew attaches a tracking transponder to the line, a device that emits a "beep" whenever it's triggered by a radio signal from the ship.

The reel begins to turn again, rumbling, and Bryan takes his position before a Precision Graphic Recorder screen in the main lab. Depth here averages something like 4800 meters (nearly 16,000 feet) and more than an hour will pass before the cameras reach bottom.

On the screen, two little blips—one round, one square—are slowly marching across a superimposed map. One is the camera, reported by the tracking system; the other, the ship. Bryan will sit here, on and off, for four hours, at first trying to keep the cameras three meters from the bottom, while they automatically clock off 720 frames, one every 15 seconds. Then he'll relax for an hour as the system is reeled in.

* * *

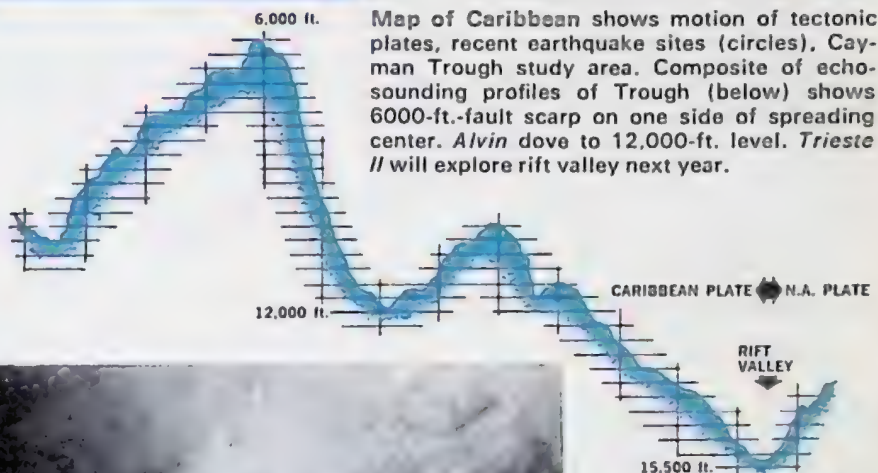
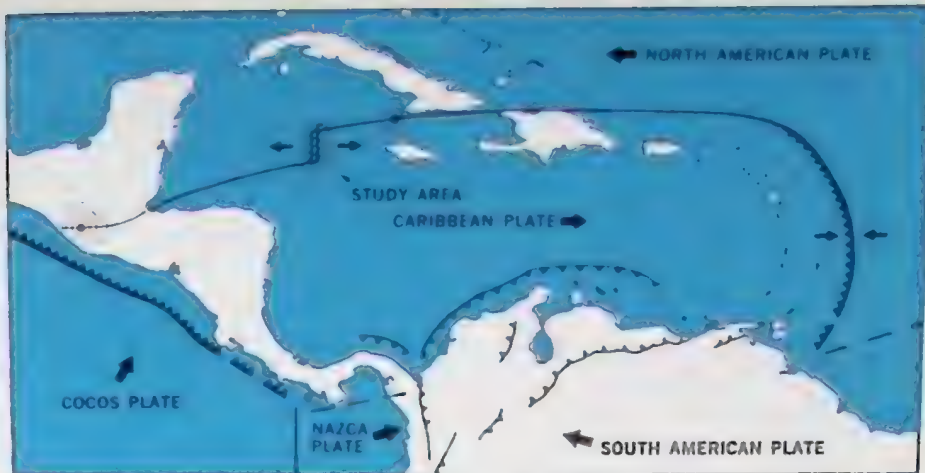
"To understand what we're doing here, to comprehend what plate tectonics is all about," Ballard had told me a few days earlier, "you've got to get a perspective of the geologic timescale." He was sitting in his cabin, with his tennis-shoed feet propped up on a table.

"Try to think of the earth as I do, as a living organism, as something with a behavior and a psyche and a response. If you were to ask a butterfly standing on a sequoia if he perceives the tree to be living, he'd say 'Of course not; I've been here all my life and it hasn't done a damn thing.' And you'd get the same answer from a 65-year-old human being standing on a 4.6-billion-year-old earth.

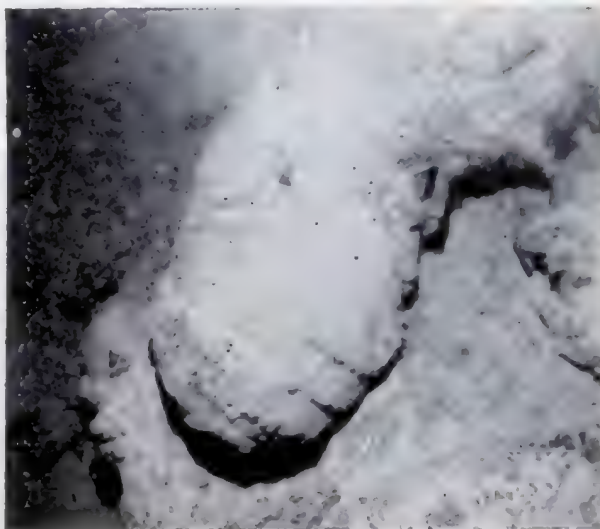
"But the earth is alive. It's dynamic, with a systematic behavior. What we're trying to do is determine the pattern."

Geologists have always tried to do that. But only in the past few years, with the nearly universal acceptance of the plate-tectonic theory, have they made much progress.

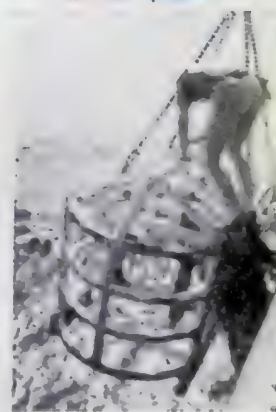
Start with a map of the world. From the time 16th-century explorers brought back crude drawings of the Americas' coasts, map-makers noticed a peculiar thing: The edges of the land on either side of the Atlantic seemed oddly parallel—a huge "S" curving from the Arctic almost to the Antarctic. Benjamin Franklin, in fact, once speculated that the earth's center might be a dense fluid, that continents "might swim in or upon that fluid," that the earth's solid



Map of Caribbean shows motion of tectonic plates, recent earthquake sites (circles). Cayman Trough study area. Composite of echo-sounding profiles of Trough (below) shows 6000-ft.-fault scarp on one side of spreading center. *Alvin* dove to 12,000-ft. level. *Trieste II* will explore rift valley next year.



Pillow-lava formation in spreading center of Cayman Trough was photographed by Angus camera sled (right) towed by research vessel *Knorr*. Formations are produced when lava is squeezed from



ocean-floor vents at about 2200° F. Volcanic material wells up where plates are moving apart. Similar formations were found by Project Famous in rift valley of Mid-Atlantic Ridge near Azores.

surface "would be a shell capable of being broken and disordered by the violent movements of the fluids on which it rested."

He was largely right. But the idea remained only an interesting speculation. The geologic gospel that dominated until the 1960's held that the earth has remained much the same since the crust solidified, with only minor changes such as mountains growing, then wearing down. The earth is still cooling, so geologists had believed, and mountain ranges are merely wrinkles

caused by the globe's contraction.

But some 60 years ago a German meteorologist and balloonist named Alfred Wegener concluded that continents drift about the earth, and that they all started in one huge continent he called *Pangaea*.

Nonsense, said the earth scientists, and they filed his notions with those on Atlantis and Noah's Ark. Still, his ideas *were* interesting:

- Mountain ranges are confined

[Continued on page 122]

The search begins for Life on Mars

Twin landing craft of Viking 1 and 2 lead a \$2-billion expedition to the mysterious surface of the Red Planet

By WERNHER von BRAUN
PS Consulting Editor, Space

Within the next few weeks, it's possible that an electrifying radio report from 200-million miles away will tell the world that there's life on the planet Mars, a discovery that would surely rank among the most important ever made by man.

The word could come a few weeks after Viking 1 touches down

on the Red Planet about July 4, a fitting way indeed to demonstrate the incredible scientific progress made during the 200 years since the birth of our Republic. Or, it could come after the descent of the Viking 2 lander about Sept. 9. Each craft will send a report after biological tests that will begin about



Marsbound, Viking 1 rides in nose of our biggest interplanetary rocket, four-stage Titan 3E, at successful launch last year. Viking 2 followed shortly. Curving trajectory is taking them on 505-million-mile journey to Mars, 200-million miles distant from Earth. Then, each Viking orbiter-and-lander will release the landing craft to descend on Mars' surface in search for life there. Powerful TV cameras on orbiters will first check out tentative landing sites. If unfavorable, they are subject to change in favor of better ones up to the last minute.

Blazing rocket jets check fall of a Viking lander from height of 4000 feet, after parachute drop, as it approaches soft landing. Sensors on footpads cut off three landing engines just before. Their nozzles tilt outward so exhaust gases won't contaminate soil samples. Cameras in twin turrets film Martian landscapes, making color and stereoscopic views.



Where landers come down is marked by ellipses on map of Mars. Tentative site for Viking 1's landing is called Chryse ("land of gold") at mouth of valley, which dwarfs our Grand Canyon. For Viking 2 it is Cydonia, near rim of north polar cap. Possible traces of water at either site would favor finding life.

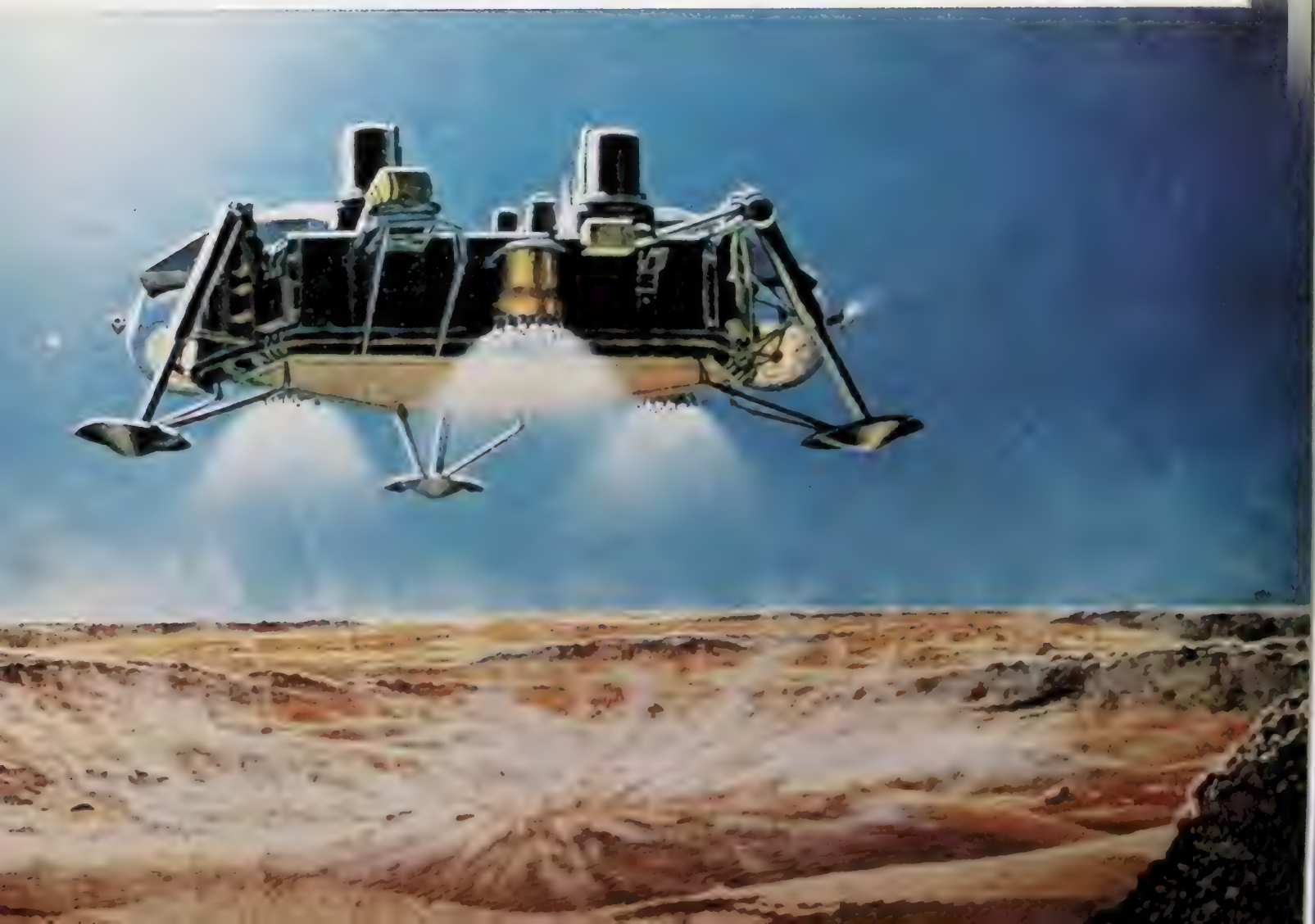
eight days after touchdown and will take some 12 days to complete. These tests are designed to reveal the presence of microorganisms—the most likely form of life on Mars, if there is any at all.

While it is even more unlikely that there are higher animals, a Viking lander's two TV cameras could detect them.

Biology experiments

Three principal life-detecting devices are aboard each Viking lander. This "biology experiment," housed in an unpretentious box the size of a large suitcase, is undoubtedly one of the most sophisticated pieces of scientific equipment ever built by man. It contains three automatic labs, a computer, tiny ovens, counters for radioactive trac-

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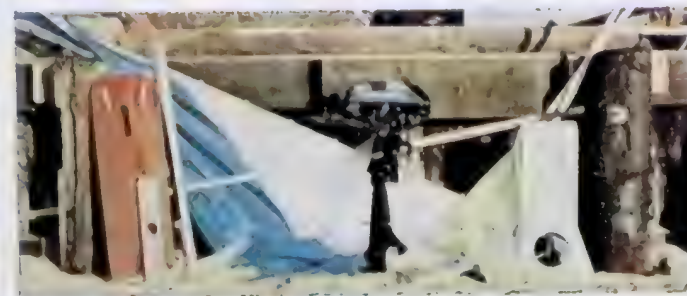


New canoes

lighter, stronger materials
make paddling more fun



PS canoes are made of clear resin over wood, canvas over wood, natural and painted aluminum, fiberglass, Kevlar, ABS.



Hull shapes show up clearly on rack: Aluminum canoes—silver Alumacraft and red Grumman—have flat bottoms with keels. Wood canoes—green Allagash and brown Old Town—are round-bottomed, keelless. Kevlar-resin Sawyer is long and narrow; fiberglass-resin Mad River has V bottom. ABS Oxford (on car) is flat-bottomed with ridge for a keel. To move a canoe (upper right) you can use a boat cart, carrying yoke, car-top pads and tie-downs. Wind or engine power (middle) are possible on many canoes—Grumman sail kit at left, two motor mounts at right. Cruising gear (bottom) includes basket and duffie packs, buoyant vests.



By ERIK H. ARCTANDER

Canoes are gliding over American waters again by the thousands, centuries after northeastern Indians invented them. Except for a few rare birch-bark canoes and some canvas-over-wood and resin-over-wood models, however, today's canoes are made of aluminum, fiberglass, ABS plastic, or Kevlar.

The new materials have a lot to do with canoeing's resurgence. Made by machine or semiskilled labor, canoes are among the least expensive craft afloat. Most of them are also stronger, lighter, and easier to maintain than traditional models.

You've probably guessed the other reasons for canoeing's appeal:

- Weights of between 45 and 85 pounds make canoes easy to carry and cartop.
- With a draft of a few inches, they go places few other craft can.
- There's no machinery to maintain and no fuel to buy—unless you add a small outboard.
- Campers, fishermen, and hunters can carry a big load with little strain.
- They store in garage or cellar.

These good reasons for taking up canoeing aren't especially new. What's new is a reawakening desire among many Americans to exercise flabby muscles, learn new physical skills, and enjoy what's left of nature without damaging it further.

As with sailing, canoeing takes instruction and practice. The penalty for plunging ahead in ignorance is a very frustrating, anxious experience and, frequently, a potentially dangerous dunking. By all means try it before investing any money. It's easier to rent a canoe than a sailboat, though your selection's usually restricted to aluminum.

How canoes differ

There is no perfect canoe at any price; each represents a trade-off in materials, hull design, and interior features. Even the experts don't always agree.

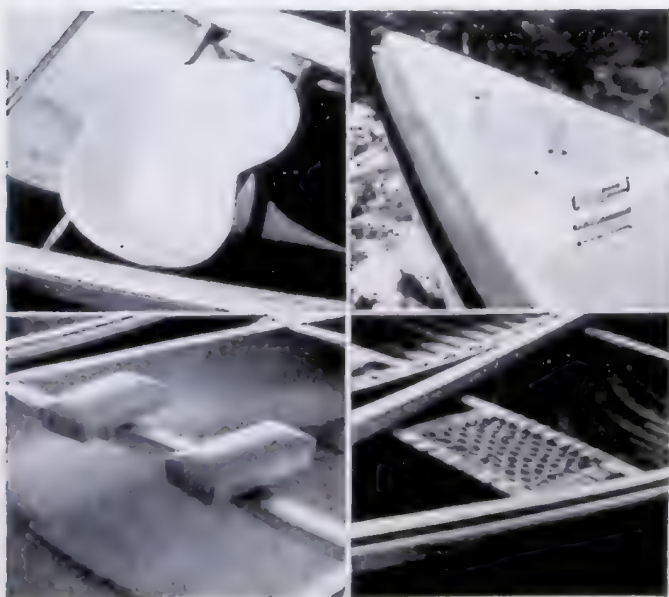
But here are some fairly safe generalizations, based on the reports of experienced canoeers, interviews with long-time manufacturers and dealers, and my own firsthand observations of the canoes shown:

Wood. You can't beat a wooden canoe for eye appeal. The Allagash 16 we borrowed is a traditional canvas-over-wood craft at a remarkably low price. Hand-built by Indians, it's sold by Great World (see Canoe Guide).

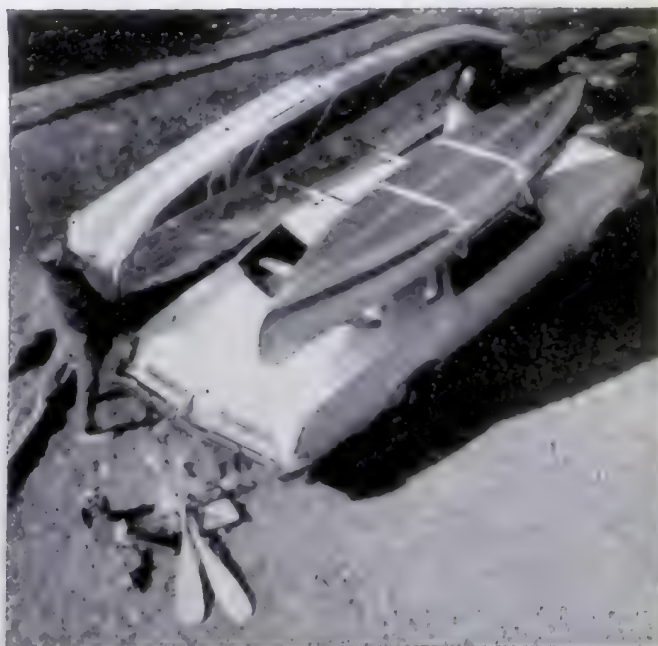
It will probably soak up five to 10 pounds of water in use, require refinishing every year or two, develop leaks or punctures more readily than other types, and it is harder to repair. But its wooden frame is buoyant and insulates against cold and water noise. Who can say how much appearance and nostalgia are worth?

Old Town's Trapper is a flawless piece of craftsmanship that deserves to hang in an art gallery. It raises pride of ownership to such a pitch that each abrasion of its varnished gunwale, each scratch on its clear-resin bottom could be like a stab in the heart. The resin, of course, prevents both waterlogging and leaks better than canvas. And it should resist puncture better and be easier to repair than canvas. Old Town makes canoes out of other materials, too, apparently to the same high standards.

Continued



Details make a difference: Sawyer (top left) uses molded seats. Oxford (top right) has handles. Alumacraft's curved thwart and bolt-on pads (bottom left) are for portaging. Allagash seats are woven rawhide, varnished.



Rack equips any car to carry a canoe; wide models handle two or three. Clamps fit roof gutter or window frame.

How the seven canoes compare

Make	Model	Material	Length	Beam ¹	Depth ²	Weight ³ (lb.)	Bottom	Price
ALLAGASH	16	Wood/canvas	15'10"	36 1/2"	13"	68 1/2	Round/smooth	\$412
OLD TOWN	Trapper	Wood/plastic	14'11 1/2"	35 1/2"	11"	63	Round/keel	\$355
ALUMACRAFT	Quetico Cruising	Aluminum	17'0"	36"	13"	75 1/2	Flat/keel	\$325
GRUMMAN	Double-End	Aluminum	17'0"	36 1/2"	12 1/2"	76	Flat/keel	\$325
MAD RIVER	Mahoeite	Fiberglass	16'7"	34 1/2"	12 1/2"	72 1/2	V-shaped	\$400
SAWYER	Cruiser	Kevlar 49	17'3"	35"	12"	46	Flat/smooth	\$195
OXFORD	17	ABS	17'0"	38 1/2"	13"	85	Flat/round	\$295

¹Widest point amidships, to nearest 1/2". ²From inside of bottom to top of gunwale amidships, to nearest 1/2". ³To nearest 1/2 lb.



C.A. NODISSETTE, GREAT WORLD

These enthusiasts are taking a post-graduate course—running through white water on Connecticut's Farmington River.



Sail a canoe? Most have an optional rig: mast, step, sail, leeboards, rudder.



Canoe provides quick, easy ride to the back country for fishermen and hunters.

You can mount an outboard on square stern (above) or a mounting bracket.

Aluminum. More aluminum canoes are sold than any other kind, and they're preferred by most outfitters. Top-quality models like the satin-finished Alumacraft and the painted Grumman are stretch-formed by machine from two 6061 marine-alloy sheets and riveted down the centerline to an inner and outer keel.

Standard thickness is a uniform 0.050 in.; both makers also offer lightweight models. The 0.040-in. Alumacraft 17-footer weighs nine pounds less than standard, the 0.032-in. Grumman 17 is 15 pounds less.

Aluminum canoes are now stronger and more rigid than ever. But they still transmit heat or cold more readily than other materials, make more noise when slapped by waves, tend to grow a layer of oxide on exposed surfaces, or the paint will tend to chip.

An aluminum canoe can pick up dents, but it takes a lot to puncture one. Dents can be rubber-ham-

mered out. Punctures are patched or welded—usually a professional repair.

Fiberglass. Fiberglass-reinforced resin—easily formed into complex shapes—is strong for its weight, bends before it breaks and returns to original shape, and has molded-in color. Fiberglass patch kits are widely available.

The strength, durability, and weight of fiberglass canoes vary considerably. Resin must be carefully formulated: hard enough to resist gouging, yet flexible enough to bend without cracking. Hand layup, often by semiskilled labor, may mean uneven resin thickness and delamination if all layers aren't thoroughly saturated.

Moral: choose a fiberglass-canoe maker carefully for his experience and reputation for quality. The Mad River Malecite I used showed every evidence of careful construction.

Plastic. ABS plastic (acrylonitrile-butadiene-styrene) is used in

at least three different ways to make canoes. The simplest, least expensive, and probably most vulnerable to damage is a single shell of homogeneous ABS sheet. Some ABS canoes have been made in two halves and joined at the keel like aluminum models; the joint sometimes splits under stress.

Most commonly, ABS is used as part of a laminated sheet, called Royalex by most and Oltonar by Old Town. Two layers of ABS sandwich a heat-expanded core of closed-cell foam between them. A vinyl skin on the outside of each ABS layer forms the hull's inner and outer surfaces. UniRoyal, maker of Royalex, varies the thickness of each layer to accommodate canoe makers.

The foam core provides some flotation as well as thermal and sound insulation. More important, the laminate stands up to brutal punishment. Oltonar canoes, for example, have fallen 800 feet from a plane, folded around a bridge

Canoe guide—a sampling of manufacturers

Company	Materials	Models
ALLAGASH	Wood-canvas	Four models 15-18 ft., \$400-446.
ALUMACRAFT	Aluminum	Ten models (three lightweight) 15-18½ ft., \$305-355.
BEMIDJI	Fiberglass	Six models 15-17 ft., \$419-559.
BROWNING	Aluminum	Five models 11-17 ft., \$265-315.
CHESTNUT	Wood-canvas, fiberglass	Forty-six wood/canvas models 11-26 ft., \$420-1542. Three fiberglass models 14-16 ft., \$363-391.
DOLPHIN	Fiberglass	Nine models 12-18 ft., \$270-365.
GRUMMAN	Aluminum	Thirteen models 13-20 ft., \$300-499. Lightweight, shallow-keel versions extra.
LINCOLN	Fiberglass, Kevlar	Seven models 11-18½ ft., \$269-475.
LOWE LINE	Aluminum	Five models 15-19 ft., \$355-415.
LUND	Aluminum	Six models 15-17 ft., \$310-355.
MAD RIVER	Fiberglass, Kevlar, Royalex	Eight models 13-18½ ft., \$335-789.
MITCHI-CRAFT	Aluminum	Fourteen models 12-17 ft., \$283-344. Sponsons optional.
MONARK	Aluminum	Three models 15-17 ft., \$292-316.
OLD TOWN	Wood-canvas, wood-resin, fiberglass, Oltonar	Eight wood-canvas models 15-20 ft., \$835-1095; one wood-resin model 15 ft., \$865. Twelve fiberglass models 10½ to 18½ ft., \$295-595; Kevlar layer optional. Six Oltonar models 12 to 18 ft., \$380-490.
OUACHITA	Aluminum	Four models 15-17 ft., \$292-320.
RIVERS & GILMAN	Fiberglass, Royalex	Six fiberglass models 11-18 ft., \$219-349. One Royalex model 17 ft., \$385.
SAWYER	Fiberglass, Kevlar	Eight fiberglass models 15¼-24 ft., \$290-375; three of these also available in Kevlar at \$200 additional.
SEA NYMPH	Aluminum	Six models 13-17 ft., \$276-298. Lightweight, shallow-keel, livery versions extra.
SEARS	Aluminum, fiberglass, ABS	Two aluminum models 12 and 14 ft., \$370 and \$420. One fiberglass model 12 ft., \$200. Two ABS models 17 ft., \$280 and \$390 (one double, one single hull).
SMOKER-CRAFT	Aluminum	Twelve models 11-17 ft., \$205-326.
STARCRAFT	Aluminum	Three models 15-17 ft., \$299-335.
WARDS	Aluminum, ABS, polyethylene	Four aluminum models 11-17 ft., \$200-300. One ABS model 17 ft., \$290. One polyethylene model 12 ft., \$150.

MANUFACTURERS OR DISTRIBUTORS: Allagash, Great World, 250 Farms River Rd., West Simsbury, Conn. 06092; Alumacraft Boat Co., 315 W. St. Julien St., St. Peter, Minn. 56082; Bemidji Boat Co., Box 249 Hwy. 2 West, Bemidji, Minn. 56601; Browning-Aerocraft, 900 Chosaning St., St. Charles, Mich. 48655; Chestnut Canoe Co. Ltd., Oro-mocto, New Brunswick, Canada E2V 2G5; Dolphin Products, Inc., Wabasha, Minn.

55981; Grumman Boats, Marathon, N.Y. 13803; Lincoln Canoes, Rte. 32, Waldoboro, Me. 04572; Lowe Line, Interstate 44, Lebanon, Mo. 65536; Lund American, Inc., Box 248, New York Mills, Minn. 56567; Mad River Canoe, Inc., Waitsfield, Vt. 05673; Michl-Craft Corp., 19995 19 Mile Rd., Big Rapids, Mich. 49307; MonArk Boat Co., Box 210, Monticello, Ark. 71655; Old Town Canoe Co., Old Town, Me. 04468; Ouachita

Marine Corp., Box 420, Arkadelphia, Ark. 71923; Rivers & Gilman Moulded Prod., Inc., Main St., Hampden, Me. 04444; Sawyer Canoe Co., 234 South State St., Oscoda, Mich. 48750; Sea Nymph, Box 298, Syracuse, Ind. 46567; Sears Roebuck & Co. (see catalog); Smoker-Craft, Inc., New Paris, Ind. 46553; Starcraft Co., 2703 College Ave., Goshen, Ind. 46526; Ward, Montgomery (see catalog).

abutment, and been thrown from a five-story building. Yet they've returned to original shape and floated without a leak. This is the ideal canoe for banging around, one builder says, though it's difficult to vacuum-mold fine lines or subtle curves into Royalex.

The Oxford (sold through Montgomery Ward as the Bicentennial) is built like some fiberglass boats. A liner of ABS is nested inside an ABS hull, fastened to it at the gunwale, and the space between filled with expanded urethane foam. Result: Its double hull floats and insulates well, and is virtually unsinkable.

The Cycloc ABS, also used to

make football helmets, is coated with acrylic to resist chalking, crazing, or fading. Though difficult to puncture, it could be difficult to patch as well.

Kevlar. Newest synthetic canoe material is Kevlar-reinforced resin. The DuPont aramid fiber is reportedly twice as strong and has double the fatigue resistance of glass. And a 17-ft. canoe weighs 15 to 20 pounds less in Kevlar than in fiberglass. Many canoeists hail it as the ultimate material for a racing craft or back-country cruiser. Having carried and paddled a Sawyer Kevlar, I agree that moving 46 pounds instead of 65 or 75—especially by yourself—makes canoeing

more fun by making it less work.

Kevlar fabric costs about 10 times more than fiberglass cloth, pound for pound. And laying it up requires more careful work—unlike fiberglass, Kevlar does not become transparent as it's wetted with resin. Thus it's harder to tell during construction when Kevlar is thoroughly saturated to form a solid hull that won't delaminate later.

However, the Sawyer's transparent-gel coat makes it possible for the owner to spot delamination if it develops—and return the craft to the manufacturer. And I found Kevlar's golden fabric attractive.

[Continued on page 118]

How to check and service your car's cooling system

By WALTER O. KOEHLER

The combustion inside the cylinders of your car produces temperatures high enough to melt the cylinder block in 20 minutes. It generates enough heat to keep a five-room house comfortably warm in zero weather.

A third of this heat is converted into mechanical energy to drive the car. But you've got to get rid of the rest or you're in trouble. Half of the waste heat goes out of the tailpipe. But the other half has to be handled by the cooling system. The cooling system gets rid of en-

gine heat by circulating a coolant through passages in the engine block. The heated water is then circulated through the radiator where it gives up its heat to the outside air. In winter, some of the heat is dumped into the passenger compartment to keep you warm.

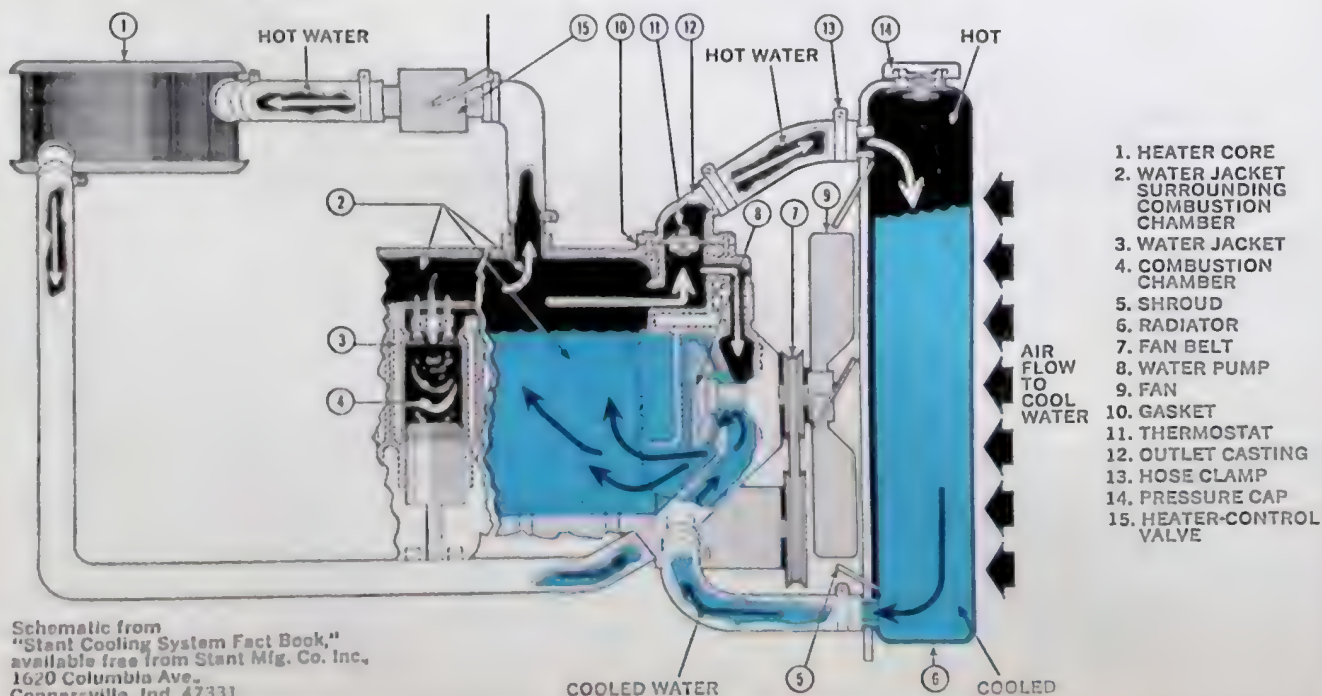
The coolant itself is a circulating liquid. Years ago, when engines were smaller, had lower compression ratios and larger radiators, and when there was more room under the hood, cooling was easier and the cooling system simpler to maintain. Car owners used plain water in the summer and a mix-

ture of water and alcohol to prevent freezing in the winter. Some car owners added a little water-soluble oil to prevent corrosion of the metal parts. The alcohol boiled easily, so a thermostat that opened at a relatively low temperature was added. But there were problems: During the winter, the engine was slow to warm up and the heater produced little warmth. In summer, boilovers were common.

The price of progress

Then things got really tough. Engines got bigger, compression ratios went up, cars got heavier, and

How a cooling system protects your engine





Upper radiator hose should be neither brittle nor spongy; squeeze to check condition, replace if needed.



Pressure cap lets your engine get hotter than 212° without boiling, but sealing seat must be pliable.

we began to hang air conditioners and other equipment under the hood, which cluttered up the area and made cooling difficult. All this prompted two major improvements that led to the modern cooling system:

- **Ethylene-glycol antifreeze.** A water-glycol mixture has a higher boiling point than either alcohol or water and permits engine operation at higher temperature. That gives better engine efficiency and more effective heating of the passenger compartment. Such an antifreeze also contains a water-pump lubricant, rust inhibitors and other corrosion inhibitors, and acid neutralizers.

- **The radiator pressure cap.** A pressurized system operates at a higher temperature without boiling. (The boiling point of a 50-50 water-antifreeze mixture now used summer and winter in a pressurized system is about 260° F.) Pressurizing also helps compensate for higher heat loads caused by the more powerful engines, heavier cars, automatic transmissions, and air conditioning.

The cooling system of a modern car consists of a relatively few simple parts: the coolant passages in the engine and head, the radiator, the coolant pump, the thermostat, the pressure cap, the car's heater, and the hoses that hook all the parts together. Regular attention will keep all these parts working as they were designed to work. And when something does go wrong, a straightforward troubleshooting routine will usually find the trouble quickly.

Before you start on vacation is a good time to make sure your

cooling system is in good condition. First step: Check coolant level. If your car does not have a coolant-recovery system (with the coolant reservoir separate from the radiator), check the coolant level only when the engine is cold. Remove the radiator cap and observe the level. It should be one to three inches below the radiator filler neck.

On cars with a coolant-recovery system, check the level in the see-through plastic reservoir with the engine at operating temperature. It should be between the ADD and FULL marks. It is normal for the coolant level to fall below the ADD mark when the engine is cold. (Incidentally, *never* remove the radiator cap from an overheated engine. Shut off the engine, raise the hood, let the engine cool for 15 to 20 minutes. Put a heavy rag over the radiator cap, grip the cap with the rag, and turn the cap slowly to the first notch to relieve system pressure. Then turn the cap to the next notch and remove it carefully.)

Next, inspect the radiator, the cooling system, and heater hoses and connections. Tighten hose clamps. Look for dampness or discoloration at joints in the engine assembly, especially at the water-pump flange. Inspect the pump itself for external leakage.

If the system is leak-free, your next step is to find and eliminate potential causes of future trouble. Examine the fan belt for frayed edges or other defects. Check tension with a tension gauge, if available, and adjust to manufacturer's specifications. If you don't have a gauge, apply pressure on the belt with your thumb at a point midway between the two pulleys that are

farthest apart. Deflection should not exceed a half inch. On most cars, adjust belt tension by loosening the alternator-mounting bolt and adjusting the arm bolt, using a pry bar to force the alternator against the belt, then tightening both bolts. Place the pry bar where it will not damage the alternator.

Squeeze the radiator and heater hoses. They should be neither brittle nor spongy. Replace any hoses that have bulges. Pay particular attention to the upper radiator hose. Since the engine moves on its flexible mountings, the upper hose is subjected to the most flexing, and is usually the first to fail. Some car owners make it a habit to replace the upper hose every two or three years to prevent trouble.

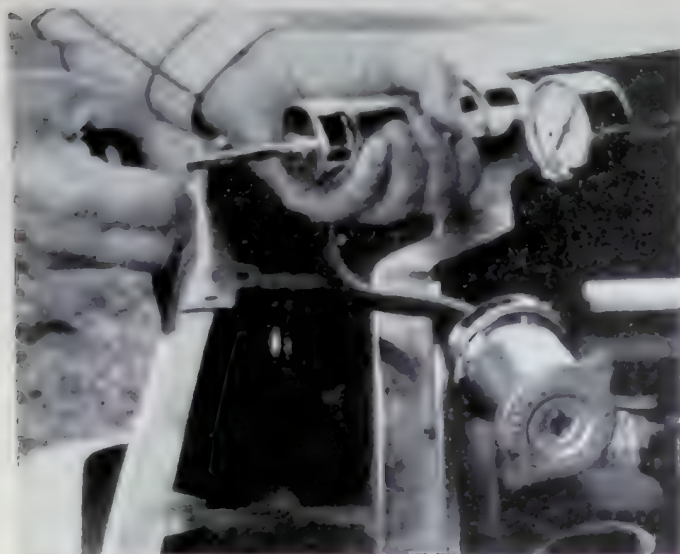
The fall flush

Once every year or two, preferably in the fall, the cooling system should be flushed and refilled with a fresh 50-50 solution of antifreeze and water. Reverse flushing is the most effective way of cleaning out the system.

One supplier of antifreeze (Prestone) offers a kit that simplifies the reverse-flushing process. To use the kit, cut the heater *inlet* hose and insert the flushing tee that comes with the kit. Secure the tee with the hose clamps also contained in the kit, and hook up a garden hose, using the coupler that's also included. Insert the kit's splash tube in the radiator filler neck. Set the heater's temperature control to maximum heat. Turn on the garden hose and continue flushing until the water coming from the radiator splash tube is clear.

Continued

Two checks with a pressure tester



Check pressure cap (left photo) by assembling pressure tester (this one is a Stant ST-255A), cap adaptor, and cap. Pump to the rated pressure. Cap should hold pressure for at least one minute. If not, change it. Next, attach tester to radiator



(right photo) and pump to the rated pressure. With system under pressure, check radiator, all hoses, connections, and joints for signs of leaks, such as discolored streaks at hose connections. Replace hoses, clamps, or gaskets as needed.

Check the capacity of the cooling system in your owner's manual and pour in enough antifreeze to give a 50-50 solution. As the antifreeze is poured into the radiator filler neck, clear water will come from the open flushing tee.

When you have poured in the necessary amount of antifreeze, replace the cap on the flushing tee. Start the engine and warm it up, then allow it to cool enough to remove the radiator cap safely. If coolant level is low, add pure antifreeze.

Troubleshooting

Two main problems can show up in your cooling system: persistent loss of coolant, and overheating. Coolant loss may be due either to leakage or boiling. A cooling-system pressure tester can be used to find troubles that could lead to either of these conditions. The tester consists of a small hand pump attached by a rubber hose to a fitting that attaches to the radiator filler neck in place of the cap. The photographs above show you how to use it. (Some authorities recommend regular spring and fall checks with a pressure tester to detect potential problems.)

If the pressure tester neither detects leaks in the system nor spots a faulty pressure cap, overheating problems may be originating elsewhere. Prime suspect: poor circulation, usually caused by a clogged radiator. To check for this condition, bring the engine up to operating temperature, then shut it off. Raise the hood, put your hand

close to the radiator, and slowly move it toward its top. You should feel a *gradual* increase in temperature as your hand moves upward. If there is a sharp change at any point, the radiator is clogged.

To clean out the rust and residue that can clog a radiator, use a radiator cleaner and follow the instructions furnished with the product. If this doesn't work, the radiator must be removed and cleaned at a radiator-repair shop. Small leaks in a radiator can be repaired with stop-leaks and sealers sold at service stations and auto-supply stores. More serious leaks require professional attention.

A clogged heater core can also cause overheating. To check for this condition, warm up the engine and turn the heater's temperature control to the highest setting. Inlet and outlet hoses should be hot.

Yet another possibility: A soft lower radiator hose will sometimes collapse at high engine speeds and restrict coolant circulation. This can be a very mysterious trouble to find. So if overheating persists, replace the lower hose.

If there is no apparent leakage or clogging in the system, but the engine still overheats, look for a defective thermostat.

The thermostat is the watchdog of the engine. It constantly monitors the temperature of the coolant and regulates coolant flow through the radiator. It operates hundreds of times during each day of driving.


A faulty thermostat can not only cause overheating, but also slow warmup of the engine in cold weather.

To test, disconnect the upper radiator hose at its lower end, where it is attached to the thermostat housing. Remove the housing and take out the thermostat. Suspend the thermostat and an accurate thermometer in a pan of water, making sure that neither touches the pan itself. Put the pan on an electric hot plate or your kitchen range. The thermostat of a typical modern car should start to open at 205° F.

If the thermostat is defective, it must be replaced. Most car manufacturers since 1971 have used 192° or 195° thermostats as original equipment. If you have to replace yours, be sure to get one with the same temperature rating. Also, be sure to replace the gasket, too.

Overheating is seldom caused by a faulty water pump, but when it does occur, it happens suddenly, due to a failure of shaft or bearings. The pump must be replaced as an assembly.

Finally, if your engine overheats and you can't find any other cause, check the ignition timing. Excessive spark retard may be the answer.

A hang-on, or after-market air conditioner, can cause cooling-system problems. Long periods of idling, for example, may result in overheating. Cars equipped with factory air conditioning may have larger radiators than those not so equipped, so a hang-on cooler may be a bit too much for the standard radiator under severe operating conditions. Oversize fan blades are available and may help. 

ADVENTURES IN ALTERNATE ENERGY

A monthly sampling of projects PS readers have devised to conserve or replace fossil fuels

Haven Noble,

Wind-powered shop



Tilting at windmills? Not quite. Noble designed the tail vane so that he could shut down the generator by swinging the vane parallel with the blades.

His 12" lathe runs "very quietly" on the DC motor. Even after heavy use, the motor is barely warm to the touch. That's efficiency for you.



By EDWARD MORAN

A well-tooled shop is a great asset if you plan to build a windmill, and the windmill can be used to power the shop once it's built. This neat example of "energy logic" is the brainchild of Minnesota DIY'er Haven Noble.

Like so many others, Noble got seriously into windmilling, compliments of this magazine. He built his first generator nearly four years ago, using plans that appeared in PS in November, 1972. He added a few creative touches of his own, such as rigid foam for blades instead of the expanded paper we'd suggested. Further, convinced that our 12-volt system would be of limited value, he rewound an automobile alternator so it could be used in a 120-volt system.

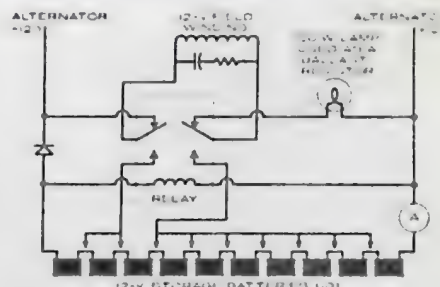
"It performs very satisfactorily," reports Noble, "and provides all the electricity for one branch circuit in my home, plus my 12-inch lathe and other power tools." The rewound alternator produces approximately four amps at 140 volts (560 watts), although Noble limits the output somewhat below this figure with a pitch-control system. The generator will produce about 400 watts in a 20-mph wind; the bank of ten storage

batteries connected in series gives four days of storage at 120 VDC.

Materials—most of them scrap—cost Noble \$175, his major outlays being \$30 for bearings, \$25 for the supporting conduits, and \$20 for fiberglass. About 200 manhours went into construction.

But the payoff comes in the form of reduced electric bills. He's been able to produce an average of 33 kwh per month over the past year. "Frequently," he adds, "we have windy days that I cannot take advantage of because the batteries have a full charge. Also, once the wind exceeds approximately 15 mph, the propeller horsepower exceeds what the generator is capable of using, and the governor limits the rpm. So, I feel the system could produce substantially more in kilowatt-hours."

There were only three days in 1975 when battery voltage dropped below 110V, forcing Noble to switch this circuit back to utility power. For small amounts of AC, he uses a 300-watt surplus rotary converter that he bought for \$25. As an experiment, he synchronized it with the utility lines and experienced a novel phenomenon—his meter ran *backwards*. The utility people were "amused," says Noble, but request-



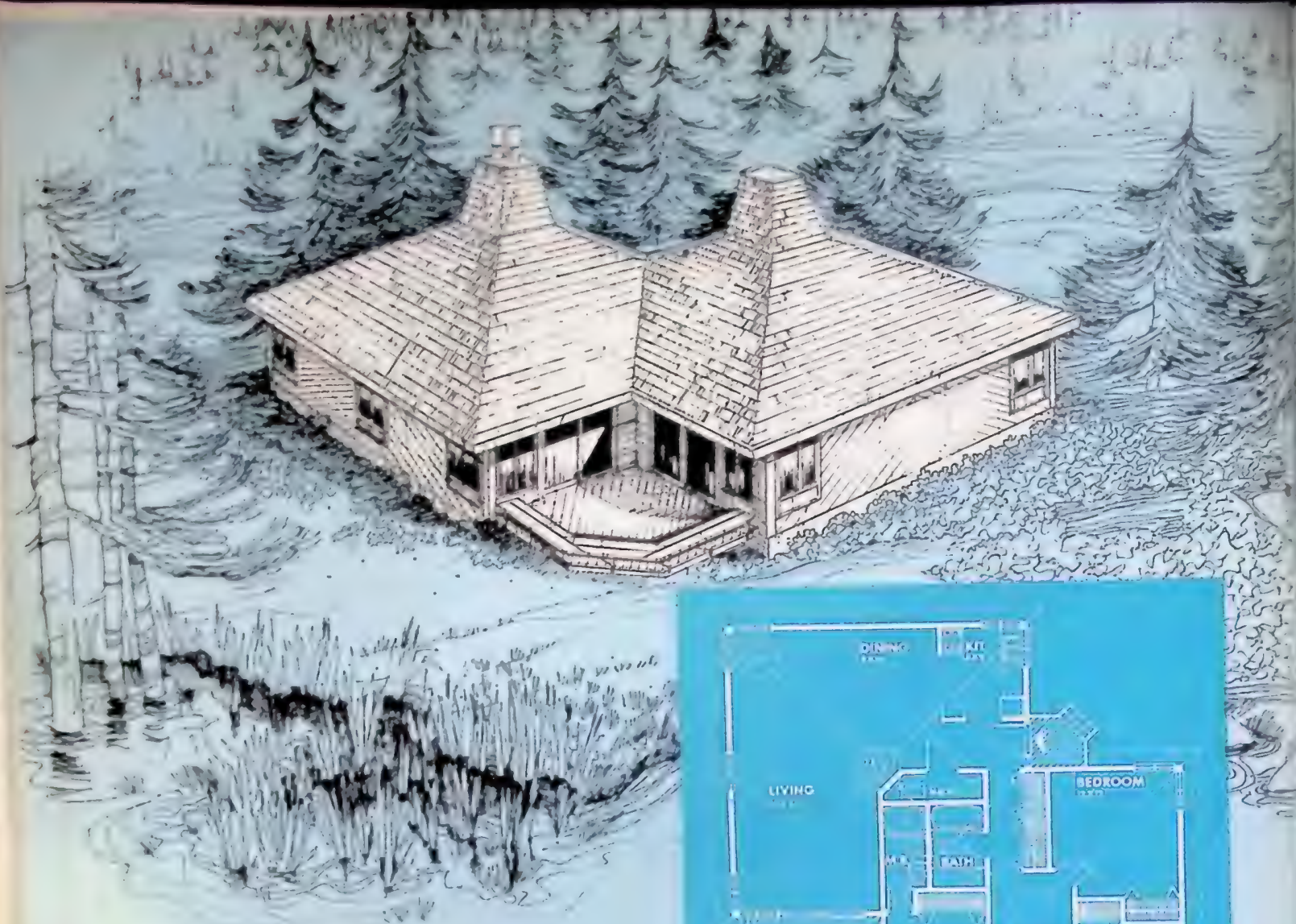
To prevent battery discharge, rotate battery field connections regularly.

ed that he "refrain from doing it on a continuous basis." [For another example of reverse power flow, see our report on the Windworks inverter in PS, October, 1975.]

The rewound alternator must still use the original 12-volt field; the schematic above shows the control circuit that automatically energizes the field when the wind exceeds seven mph. No wind vanes or sensors are required for the circuit.

All electric hand tools—saws, sanders, drills—work fine hooked up to the windmill, since they use universal motors. Make sure larger tools have a switch rated for DC.

To ask a specific question, send a stamped return envelope to Haven Noble, Box 453, Lewiston, Minn. 55952.



PS leisure-home plan

Twin pavilion



Two interlocked squares set the format for this delightful house. Each sports a pavilion-style roof with a thrust center. Above the living/dining square, this topknot carries the flues for the freestanding fireplace and the furnace (or even the bathroom vent). Equally striking, the tip of the matching peak is a skylight to illuminate the central hall shared by the three bedrooms.

The pyramidal character of these roofs can also enhance the interiors if you leave the rafters exposed (by applying rigid insulation between the decking and shingles). But if overhead storage space is needed, you can frame in dropped ceilings, especially over the bedrooms.

The main entry is from a small deck at the back. From here, a corridor leads to the main bath and that central "atrium" hall. Note that

the master bedroom (largest of the three and with its own deck access) has a private bathroom that shares a plumbing wall with the main bath. Beyond the entry is an open kitchen with a divider counter that serves as a snack bar or a serving buffet for the adjacent dining area.

On a sloping site, the architect suggests that you orient the house to put the upper left corner of the plan downhill. If the slope is steep enough, this lets you tuck a lower level under this section for a utility or family room. You can provide connecting access by means of a spiral stair in this window corner, as shown in dashed lines.

This is another in a series commissioned for PS from Robert Martin Engelbrecht by V-PAC Council—a building-materials group promoting quality leisure-home design.

Note that the siding is applied diagonally on the long walls, for a novel chevron pattern. The windows are all stock units, double-glazed, given a distinctive treatment by framing in a feature panel below each pair. This panel can take a room air-conditioner where necessary. Total floor space is 1372 sq. ft.—not counting the bench-railed deck, which will serve as another room.—*Al Lees*

Several ways to order plans

Twin-pavilion study plan (#1) is a floor plan with additional data. Plans from our earlier series—plus others not published in PS—are cataloged in a pair of Illustrated V-PAC GUIDES (#3 brings you both). Twin-pavilion blueprints are \$35; three sets, \$45; postage and handling within U.S., \$1.50. Send orders to Vacation Plans Service, Box 622, Princeton, N.J. 08540 (no COD; U.S. funds).

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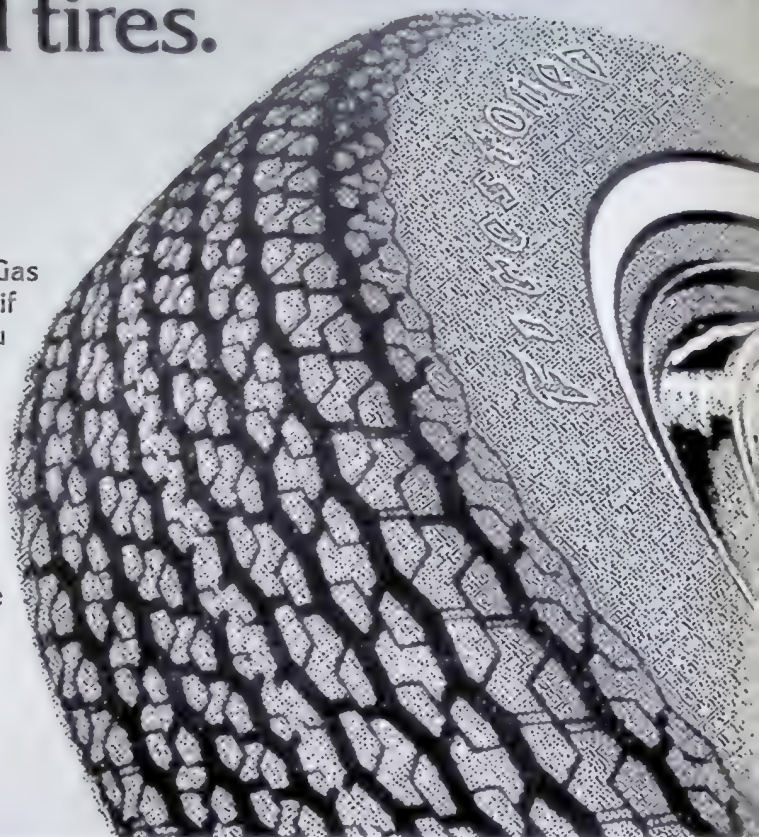
Who and what to ask before you buy steel belted radial tires.

1. Ask your tire dealer to tell you all this:

Ask if his tires have earned the reputation of "The Gas Savers"—and have the test data to back it up. Ask if he will let you drive on them for 7 days and give you all your money back if there's anything you don't like. Ask him if his tires have a Water Squeezer Tread that keeps more rubber on wet roads, and two steel belts to put steel between you and tire trouble. And ask him if this is the kind of long mileage radial tire that gives you honest value for your money.

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Don't forget—the safety of your tires is also affected by air pressure, wear, load, and operating conditions.



Solar architecture

[Continued from page 52]

6½-inch batt in all roof joists. All windows are double pane."

The addition's striking south-facing facade supports 18 three-by-seven-foot Sunworks air-type collectors, which store heat in a 1000-cu.-ft. rock bin (see drawing).

Liquid-type Sunworks collectors provide domestic hot water. The collectors are mounted on a small, freestanding structure next to the addition, and operate on the thermosiphon principle [see drawing and "Solar Water Heaters You Can Buy Now," PS, May].

There's yet a third solar-heating "system" at work via the passive approach: direct heating of the house through south-facing windows. Explains Price: "The passive system makes up the missing 20 to 30 percent of heat needed and eliminates the need for a fossil-fuel backup system."

A small woodburning Jotul stove provides the only backup for the addition. A greenhouse, located under the air-type collectors, is insulated at night by Skylid panels, another Zomeworks product (shown open in the photo). The Skylids

(fiberglass-filled aluminum sandwiches) operate automatically via an ingenious arrangement of two Freon cannisters. During the day, the sun's heat causes Freon in one cannister to expand into a cannister on the panel's opposite side. The shift in weight pivots the panel open; at night the process reverses to close it.

No afterthought

Alan Lower, Oklahoma City-based architect, designs solar homes that integrate the solar-heating components with the structure rather than having them appear to be an afterthought. The Engle solar home, located near Wagoner, Okla., (#4 on color pages) is Lower's first. A major design element of the structure—the steep, 50° roof plane—positions the collectors so that they're perpendicular to the sun's rays at low winter-sun angles.

"Architectural systems are important to the efficiency of the home," says Lower. "Roof overhangs shade south-facing windows during hot Oklahoma summers, but let in sun during the winter months.

All glass is double pane, walls above and below grade have six inches of insulation, and roof and ceiling areas have 12 inches."

The home's heating and cooling system uses Energy Systems, Inc. liquid-type copper collectors (see drawing). The heat-storage tank is compartmentalized; the entire tank—2000 gallons—stores heat in winter when lower-temperature water is sufficient for space heating. In summer, only 800 gallons are used so that higher temperatures can be reached. This water—195°—will be supplied to a lithium-bromide absorption chiller for air conditioning [see "How Solar Heat Can Cool Your Home," PS, Sept. '75] when these units are available.

Solar vacation home

Blue Minges, of Blue/Sun Ltd., Farmington, Conn., designs and builds marketable solar homes:

"We need to have a house the public will accept, as well as one that is energy-balanced and adaptable to solar." Indeed, take the Grumman solar collectors off the cedar-clad vacation home Minges

[Continued]

designed for builder Bob Terrosi in Quechee, Vt. (#5 in color pages), and the house would look like many others. But this house is packed with energy-conserving features.

Says Minges: "There's a lot of heat lost in conventional framing through the studs, which, of course can't be insulated. We used post-and-beam construction and overhung the exterior wall—2x4 studs with cedar siding—1½-inch outside the framework. We sprayed 2½ inches of polyurethane from the inside; this gives an effective thermal barrier—no studs go "through" the wall from inside to outside—as well as an R-20 insulation rating, the equivalent of six inches of fiberglass. The roof has three inches of polyurethane and 2¾-inch Homosote decking.

The home's vertical, three-level floor plan provides natural cooling. "Crack open one of the sliding glass doors on the lower level, open a window up in the loft, and the whole house is aired out in five minutes," claims Minges.

The collectors do not face due

south; instead, the house is orientated 20° west of south to take advantage of prevailing southwesterly summer winds. Also, the cool, hazy mornings and warmer, clearer afternoons in this part of the country make a slightly westerly-oriented collector more effective.


Solar economics

What does all this add to the cost of a house? "We try to promote the simplest, least complicated ways to use solar energy," says TEA president Anderson. "Put a window on the south side instead of the north side; orientation costs no more."

Extra insulation, double-pane or storm windows, and insulating shutters will add some to the cost. (There's now a computer analysis service, offered by the York division of Borg-Warner, that will tell you what these extras will save before the house is built—see *Shop Talk*, this issue.)

Is the solar hardware competitive? Grumman has computed comparison figures for Minges' house in Quechee. Total annual costs, in-

cluding mortgage payments, maintenance, fuel and electricity, are \$1844 for electric heat and hot water; \$1303 for the solar system; and \$1024 for oil heat and electric hot water. While a solar system competes with electric heat in this case, oil still has the edge—at present prices. Of course, comparisons depend on climate and the cost of available conventional energy.

Finally, consider that a home built and purchased today, on a 30-year mortgage, won't be paid for until 2006. What will oil or electricity cost then—if they're available for home heating? 

Manufacturers' addresses

Energy Systems, Inc., 634 Crest Dr., El Cajon, Calif. 92021. Grumman, P.O. Box 365, Bethpage, New York 11714. Sunworks, P.O. Box 1004, New Haven, Conn. 06508. Zomeworks Corp., P.O. Box 712, Albuquerque, N.M.

For further reading

Energy, Environment and Building, by Philip Steadman (New York: Cambridge Univ. Press, 1975). \$5.95.

Low-Cost, Energy-Efficient Shelter, Eugene Eccli, ed. (Emmaus, Pa.: Rodale Press, 1976). \$10.95 (hardcover), \$5.95 (paper).

New Low-Cost Sources of Energy for the Home by Peter Clegg (Charlotte, Vt.: Garden Way 1975). \$5.95.

Solar Energy and Shelter Design, by Bruce Anderson. Available from TEA, Church Hill, Harrisville, N.H. 03450. Price: \$7.

Catalog on Solar Energy Heating and Cooling Products, ERDA, Government Printing Office #052-010-00470-1. \$3.80.



2. Ask a friend about Firestone.

"My first car, an antique Model A Ford, had Firestone tires, and after 10,000 miles they hardly showed any wear. So since then I've bought about five sets. I've been well satisfied...that's a fact." Bernie Putt, furniture manufacturer.

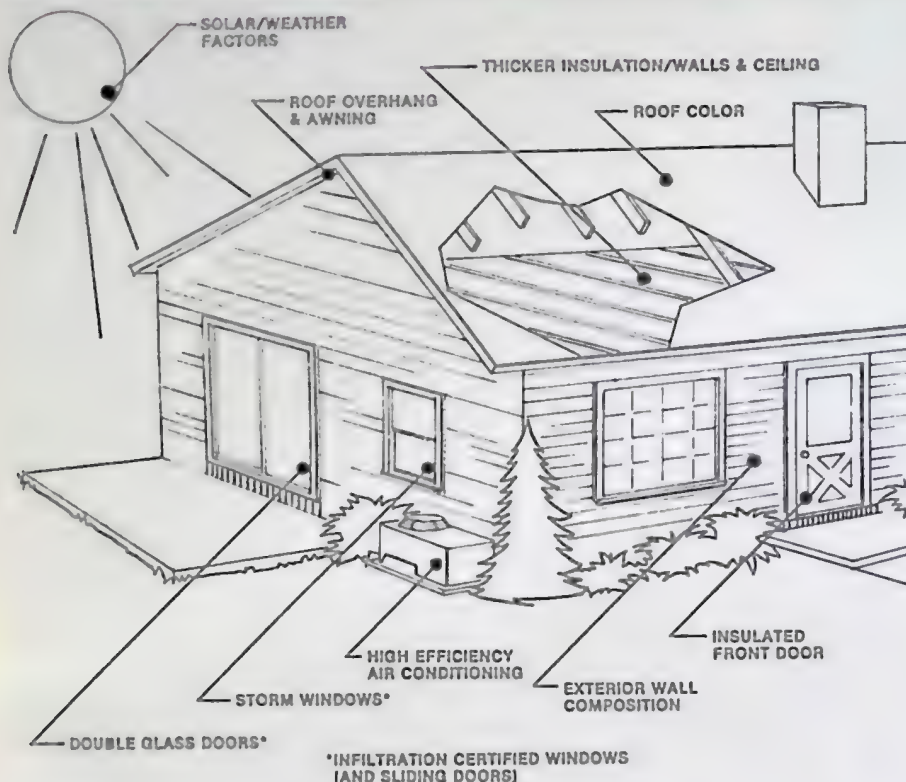


Firestone

The New Steel Belted Radial 500.

SHOP TALK

By RICHARD STEPLER



Computer energy audit

In May's Shop Talk I reported on a company that provides specific dollars-and-cents advice to homeowners on energy-saving improvements based on cost effectiveness. But what if you don't have a home yet? Maybe you're in the planning stage, trying to balance design and energy-saving options while staying within a budget. How do you determine if extra-cost energy-saving options will be economically justified in a house that doesn't yet exist?

You do it by computer: You, the home buyer—or your builder—go to the local York dealer and fill out a computer-input form with such information as building materials to be used, size and orientation of house, number and area of windows, local utility rates, and mortgage terms.

The dealer sends the form to York's central computer, which is programmed with weather and solar data, and insulating efficiencies of all types of building materials. You get a printout that lists energy-saving options, their cost, what each will save in heating/cooling costs annually, the additional mortgage cost per year, and the net savings—if any. Examples of house modifications considered are shown in the drawing above.

The computer also evaluates heating systems (oil, gas, or electric) and orientation of the house. For complete cover-

age of the energy-saving options now available, all York has to add is data on solar heating and cooling systems. [See "Solar Architecture: It's More Than Putting Collectors on the Roof," this issue.]

For more information on YES (York Energy Saver) computer analysis, write York Div., Borg-Warner Corp., Box 1592, York, Pa. 17405.

Metric nuts and bolts

In spite of tradition and the U.S. Congress, the metric system is slowly but surely replacing our awkward and outdated English system of weights and measures. Latest entry: The Industrial Fastener Institute has published a 306-page handbook for the fastener industry. *Metric Fastener Standards* is divided into seven sections: screw threads; materials; bolts, screws, and studs; slotted and recessed screws; nuts; non-threaded fasteners; and technical data. To prevent confusion between metric and conventional U.S.-made fasteners, the handbook also establishes a new head-marking symbol as a metric identifier.

Metric Fastener Standards is available from IFI, 1505 E. Ohio Bldg., Cleveland, Ohio 44114. Price is \$35.

Solar catalog

Need components for your do-it-your-

self solar-heating system? Or want to buy a complete, off-the-shelf system from panels to storage, including controls and pumps? Get the "Solar and Alternative Energy Catalog" from Solar Usage Now, 450 E. Tiffin St., Bascom, Ohio 44809. It's \$1.

Projects directory

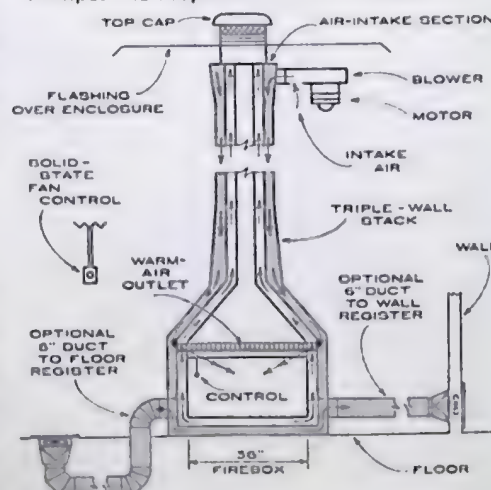
Recall a project recently that you'd like to build but can't remember what issue of *Popular Science* you saw it in? Subscribe to *The Home Projects Directory*, and your problem is solved. The directory indexes projects in PS, plus five other major craftsman magazines, as well as the special projects from such periodicals as *Better Homes and Gardens* and *Sunset*. It's coded so that different project areas (woodworking, home and shop improvement, and maintenance, electronic, automotive and metalworking, and crafts) can be filed together. A year's subscription (four issues) is \$3.98 from Camby House Publishers, 3517 Camby Rd., Antioch, Calif. 94509.

Where there's fire, there's heat

The inclusion of Majestic's latest wood-burning fireplace in our "Energy-Saving Addition" [PS, Apr.], prompted reader Leon Gaiser to write of his experiences:

"I recently installed one of these in the interest of energy conservation. It seems that Majestic forgot this is a zero-clearance unit. Therefore, little heat is trapped in the outer section of the triple-wall stack. Majestic is now working on the problem, I'm told. Meanwhile what do I do about the cold attic air being circulated through the house?"

We put the question to author Mack Phillips. His response: "I'm not aware of



any problem with the Majestitherm fireplace. Majestic did make a change in the top housing, however. They sent us an "improved" one to replace the one shipped with the unit. It came before we installed the fireplace, so we simply used the new one. Therefore, I've no idea what it contributed to performance."

Does the fireplace work? Says Phillips: "I had a real good fire going on our last chilly night, and when I turned the blower on, the air was so hot it'd burn your hand."

REVEALED — THE SECRET, YET LEGAL WAY TO GET ANYTHING YOU WANT.

MY FRIEND,

I'm getting old, and I don't have much longer to live. Unless I do this now, when I go the secret goes with me.

What I am about to give you is KNOWLEDGE . . . the knowledge that men have been searching for since time began.

I used to be an ordinary man. I spent the early part of my life stumbling in the dark, trying to find a way to make all the dreams I had as a young man come true. I wanted, like most people, to be wealthy, admired, respected. I wanted love and happiness. I also had many questions about life and I wanted some answers. Yet, no matter how hard I tried, everything always seemed to be kept from me. As though it was all hidden in the very next room, a room whose door was impenetrable without the right key.

After years of being kept from those things that I wanted most in the world my spirit could have easily broken if I allowed myself to become consumed with failure and rejection. Little could I know then how lucky I was for this to have happened to me. For something grew inside me that would not let me rest until I found the answers that would bring me all the things I so desperately wanted.

This was the beginning of a search that would become an obsession. To find the knowledge that I so desperately longed for and knew must exist somewhere. The inspiration of the great men of the past took much of the torment away. The multimillionaires and recluse billionaires that seemed to have the world at their beck and call. The men that were able to control the very destinies of nations. How they held respect and admiration, how they were rich and powerful but not me, never me. What did all these great men have that I didn't? I knew there must be an answer and I dedicated my life to finding it; because I knew there could be no true life for me until I did.

I started to read, to do research into the past. I spoke with and studied of the richest, the most powerful, as well as the wisest men of my time. I read every possible piece of literature that I thought would hold a clue. I delved into the oldest recorded writings of the ancient civilizations. I studied and I learned. Trying almost insanely to put all the pieces of this great puzzle together. I kept asking, myself, what did these men have? What did they have that I didn't and how could I get it?

I involved myself in all sorts of situations trying to put into practice what I had learned. I traveled

with the hope that the answers might somehow lie beyond the horizon and though I didn't find them there, I now know that the proverb, "Seek and ye shall find," couldn't be more true. *For when the answers were finally revealed to me they came in a way that I could not directly attribute to any place I had been or any individual effort I had made to find them.* It was as though my mind had crossed into a new frontier, a frontier that I was certain relatively few men had ever gone into before. Suddenly I saw the whole world differently, what seemed confusing before I could easily understand. What was unobtainable before suddenly became easy to get. The things that people saw one way I saw differently as though I could detect more aspects of the same thing and thereby see it more clearly or as it truly was. I had an undefined power that gave me an advantage over everything I did. After a while I realized that I was very different from before. I was at last the way I wanted to be. I had learned what I wanted to learn and was at long last able to live the way I had dreamed and knew it was possible for a man to live.

It is written, "Once in a thousand years, a man lives a dream." For the last 1/3 of my life that is exactly what I have done. I have lived with more wealth and power than any man could ever want. I have done almost everything that I ever set out to do. I doubt if there has been a man who has lived a more fulfilled life than I. But now I have only memories. This, in my opinion, next to life itself, was the greatest gift that a man could be given. But now I have come to realize that if I don't share this knowledge now I may never get another chance to do so. I now know that I am obligated to share it and in the end this was the way the fates had destined it to be.

I know that most people who read this letter will think I'm a crackpot, a fraud, a liar. They won't believe that I have this knowledge or at least that it could be put into a book and taught to them. For them I am truly sorry, for they unfortunately, still have the same tendencies, even in this technological age, as did the early cave men, who never wandered far from the security of their caves, who unwittingly traded the wonders and secrets of the outside world for it. Those few who ventured outside have always and will always be the few who reap the rewards. The few that are remembered when everyone else finally sees that it's safe to follow. The few who will always be a step ahead of and have the advantage over everyone else. Life holds next to nothing for those who cannot see beyond the present time, who believe that their own little world of intellect is the final answer.

This letter then is intended for the few who have not yet submitted to the world and become total slaves to society. The few with the spirit and guts to want more from life than they have been told all their lives by those with nothing that they could get. The few who believe there is more to life than most people think is possible and want it as I did when I was young.

I cannot know if you are one of these unique people. I will only know that when I receive your name on the order form below. If you want a copy of this book and want to learn this knowledge and want the rewards knowing it will bring you; send me the enclosed order form with ten dollars for payment in full. I urge you to send for it NOW . . . it will be the smartest thing you've ever done.

I have received testimonials for my book from doctors, lawyers, businessmen, even from U.S. Senators, as well as orders from the largest corporations in the world such as: I.B.M., Coca Cola, Xerox, Franklin Life Insurance, General Motors, Ford, Pepsi Cola, C & P Telephone, Dupont, 3M Company and many others.

Cordially,

Robert Collier

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P.S. I hope you don't think that I'm only interested in your ten dollars. I would like to give this book to everyone free, but I have found that people appreciate as well as apply themselves wholeheartedly when they have to pay for it. Besides with the costs of labor, mailing, this ad and printing I hope at best to just get my costs back to inform as many deserving people as I can before the end. I think it only fair to warn you though, that this book contains only 344 pages yet, people that have read it through have experienced a drastic change in their attitude and outlook of life. Once you read this book you can expect a very drastic change in your life as well. The knowledge within it will give you a distinct advantage over everything you do, an advantage you never had before. Although this may seem like a good thing to you, there are many people who are very happy to be failures and actually enjoy having to feel sorry for themselves and once they read this book through they can never expect to do that again.

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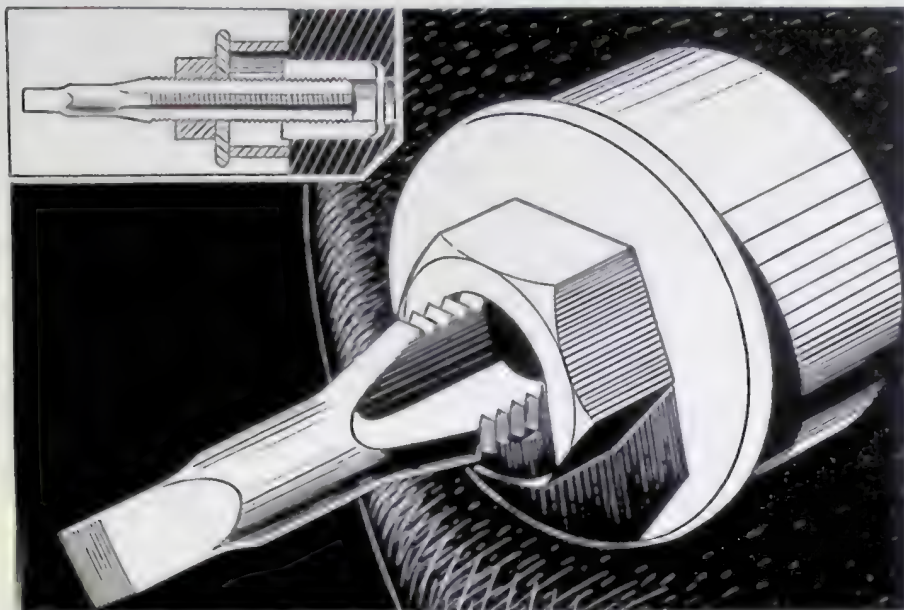
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() Here is an extra \$2.00 (\$12.00 total). Please send the book VIA
SPECIAL DELIVERY.

TAKING CARE OF YOUR CAR

By RAY HILL

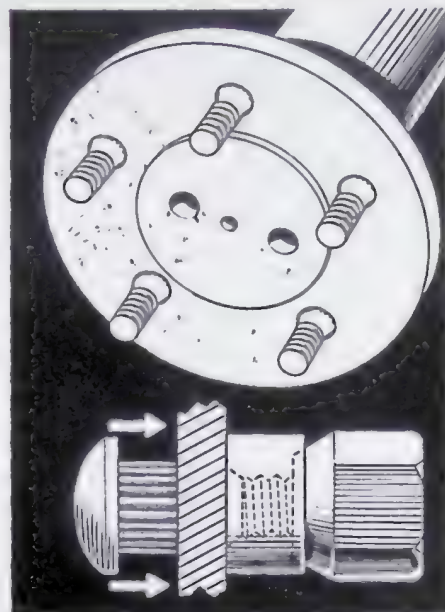
Got a useful car tip? Send it (with Social Security No.) to Car Care, Popu'ar Science, 380 Madison Ave., New York, N.Y. 10017. We'll pay you \$25 if we use it. If two or more readers send in the same usable tip, the one with the earliest postmark will be chosen. Sorry, but tips can't be returned.



Removing troublesome bushings

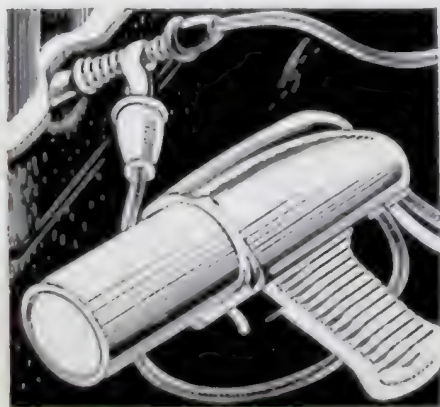
To pull a bushing from a hole that's open at only one end—such as in a starter or generator—screw a standard tap into the bushing. Then place a small piece of pipe (or a large nut—anything that can be used as a spacer), flat washer, and nut as shown. Hold the tap with a wrench to

prevent it from turning, and with another wrench tighten the bolt, withdrawing the bushing. Make sure the inside diameter of the nut or pipe you're using as a spacer is large enough to allow the bushing to be drawn up into it (see section), or you'll be working against yourself.



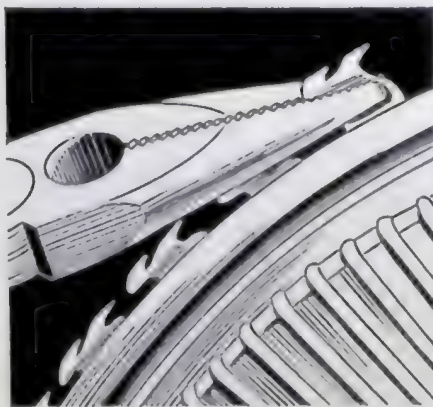
Replacing rear-wheel studs

Rear wheel got a broken stud? You probably won't have to remove the axle to replace it. Knock the old stud out with a punch. Place the new stud in the hole, making sure the splines on the stud are lined up with the axle-flange splines. Draw stud in with a spacer and lug nut.



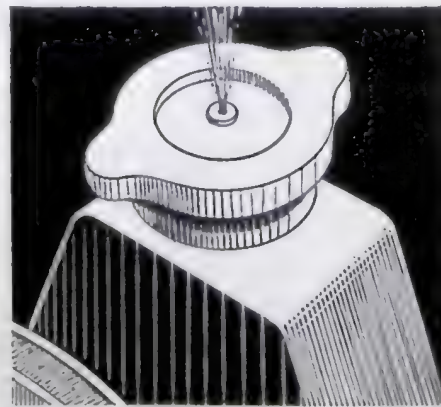
Finding a dead cylinder

Although a timing light is in no way a replacement for an ohmmeter, it can be used for a quick on-the-spot troubleshooting tool where no ohmmeter is available. Say you've got a dead cylinder on a V8 in a crowded engine compartment, where removing plugs and plug wires to check for spark isn't so easy. Hooking the timing light to each cylinder will tell you which one isn't firing. No firing, no light.



Renewing old hubcaps

If you've just replaced a flat tire and found that the hubcap doesn't grip firmly when you put it back on, check the teeth around its inside edge. They're probably bent or deformed. With a pair of pliers, "reset" the teeth so that they're all uniform and provide a solid grip when the hubcap is replaced. This can save you the price of a new hubcap because you won't have an old, ill-fitting one flying off into a ditch somewhere.



Power-steering-pump noise

Air in the system will cause this pump to growl when you turn the wheel. To get rid of the air, add enough fluid to bring the fluid in the reservoir to the proper level. Then, while the engine idles, turn the wheel back and forth from left to right (from lock to lock, but without hitting the steering stops). Keep doing this and adding fluid until the fluid level stays constant and the growling stops. Replace the cap each time.

A road toughener can prevent more than just potholes.



When an unexpected bump jerks the steering wheel, a pothole can turn from a nuisance into a very real menace.

Drop a wheel into a pothole at forty miles an hour, and you can blow a tire, break a wheel, even skitter off the road.

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already using the underliner to reinforce runways.

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A clinic on cars by Smokey Yunick, America's most famous mechanic

Clean engines for synthetics

I have a '70 Dodge 318 c.i.d. with 75,000 miles on the clock. I am considering changing to a synthetic oil after reading the article in your April issue. I imagine that the oil—I'm thinking of a polyol—would last for 25,000 miles. I get good mileage and performance with my present mineral oil, so do you think a changeover would be wise?

Ed Kelly, Lansing, Mich.

I'm glad that this question has come up, because I generally don't recommend changing to a synthetic oil when you have a high-mileage engine. If you know the engine is in good shape, has good compression, good valves, and is clean, it would be okay. But I know from experience that most old cars aren't in that kind of condition. Engines that have used mineral oil for a long time tend to be very dirty and badly carboned. While most of the new oils would mix well with the mineral-oil residue, there is a distinct chance of an adverse chemical reaction with those other deposits (carbon, sludge, etc.) that have built up in the engine. The new technology is still in the growing stages, so I'd recommend that you stick to your mineral oil. Wait until you have a clean engine before using a synthetic.

Cooling down the engine

I've heard that after a prolonged run at highway speeds, it's a good idea to let the engine idle for a while before shutting it off. How does this benefit the engine?

Theodore Main, State College, Pa.

This is done to allow the engine parts to cool down gently, since abrupt temperature changes can and do cause stress on the parts. Doing this could give you longer service and save on maintenance costs, but most cars are not worked too hard, so benefits will not be very noticeable. However, this is a common practice on commercial and industrial vehicles, driven much more rigorously.

Hubcaps and balancing

When wheels are removed from a car to be statically balanced, the hubcaps are taken off. Once the wheels have been balanced and put back on the car, could the hubcaps cause an imbalanced condition when they are fitted back on?

Marvin Larson, Los Angeles, Calif.

You're quite correct. Hubcaps can and do cause an imbalanced condition, and the bigger and heavier the hubcap, the more this condition is aggravated. Per-

sonally, I see no reason for these fancy monsters, since they seem to serve little purpose.

Vibration on a Ford

My 1975 Ford Mustang II with steel radial tires has suffered from front-wheel vibration ever since I bought it. I have had the steering box adjusted, alignment checked, and the tires both statically and dynamically balanced, but all to no avail. Mechanics say that it's a design problem and can't be corrected. Do I have to live with it?

George Snavely, Burke, Va.

Ford is aware of the problem, and has designed a new and improved steering-gear mounting bushing, which will be available in the near future. I suggest that you contact the Ford district office nearest you to find out the procedure for having the change made.

Slipping into neutral

I shift my automatic transmission into neutral on stopping. I thought that by doing this I was saving on fuel, and also preventing wear and tear on the transmission. But I read recently that this practice may be illegal in some states, and could actually damage the transmission. What do you think?

Richard Zaranko, Flushing, N.Y.

I'm not an expert in law, but if this is an illegal procedure, I hesitate to comment on the intelligence of the lawmakers. (It could be potentially dangerous in heavy stop-and-go traffic, especially if you're tired, with slow reflexes.)

If you hope to reduce transmission wear by this method, I doubt that you are making much impact, and I would recommend that you simply follow the manufacturer's directions.

As far as fuel consumption is concerned, I experimented with an automatic on a cross-country trip, trying both ways, and found little difference. Some of today's transmissions are tied in with emission controls, so there may be a chance of saving a little, but the amount would be very small.

Seasons heatings

This problem with my 1974 Mazda RX-4 occurs only during the summer months when the air conditioning is operating. When the engine is turned off for a while, I experience difficulty in starting up, the idle is very rough, and there is a large, but seemingly safe, increase indicated on the temperature gauge. Do you think that installing an electric fan

similar to those found in VW Rabbits would solve my problem?

Robert Hensley, Baton Rouge, La.

At low rpm, small engines, especially small rotaries, have very minimal torque, and under-hood temperatures increase due to engine lugging and restricted air flow when the A/C is on. This combines to increase the carb temperature, which therefore interferes with the engine's delicate air/fuel ratio. This causes the difficulty in starting. Therefore, check your carb and ignition specs, as there is no room for variance. I don't see the necessity of installing a fan on a standard-make road car if your cooling system is in good operating condition. But remember: If you do install one, you will need a thermostatic control.

Ignition troubles

Ten months ago, I had an electronic ignition installed on my Pontiac Ventura 250-c.i.d. six-cylinder. Recently, the car began to backfire, and the engine runs rough. I took it to a tuneup shop, where new plugs and wires were installed. After 12 engine starts the car was back in the shop again with ignition problems, and has been there four times since. The shop says that the ignition system is poor; the supplier disagrees.

Ken Odergard, Bozeman, Mont.

I have cautioned readers several times in the past on the pitfalls of electronic ignition. Many systems on the market are badly made, electrically mismatched, and lead a short, troubled life. If your tuneup shop is reputable, I recommend that you follow the shop's advice, and either return to a standard ignition for the model or invest in a name-brand system, since a good system should be troublefree for years.

Rattles galore

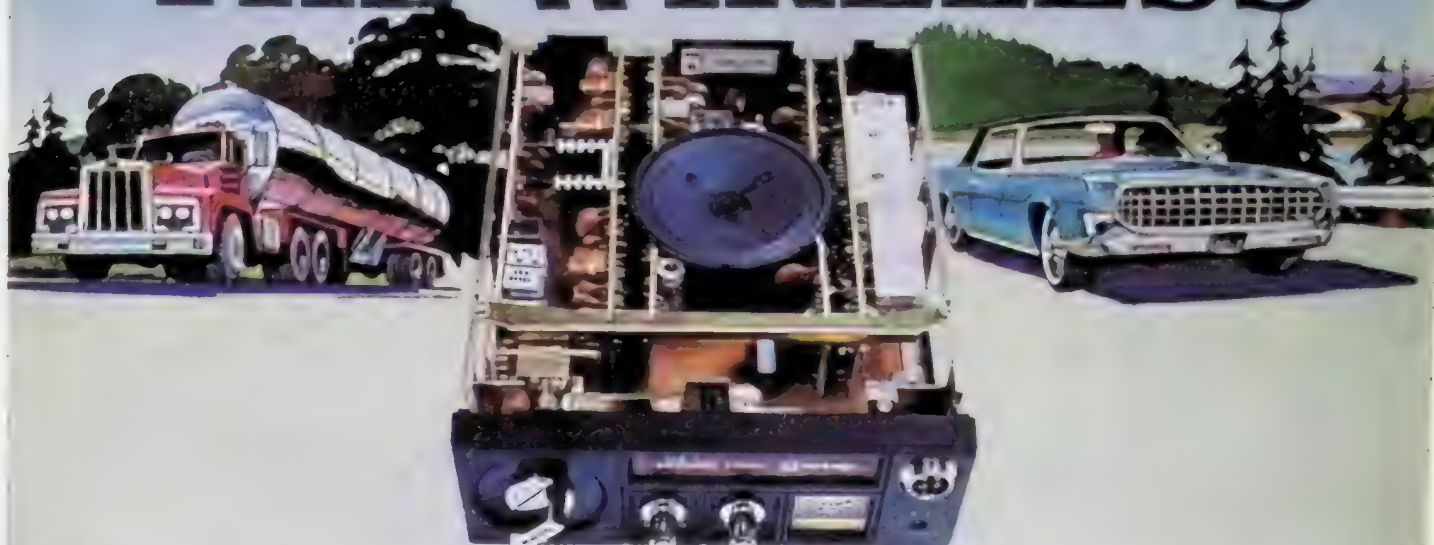
I have a '73 Mazda RX-3, which is in great shape mechanically, but rattles annoyingly. I don't want to trade the car in, but the constant noise from the doors, windows, and dash makes driving unbearable. What's the solution?

Peter Hof, Whittier, Calif.

I believe that the only solution is first to tighten all the doors and windows and then completely spray all the accessible parts and the underbody with a sound-deadening material. Include the inner doors and body panels, but don't forget to reopen the drains in the door, quarter- and rocker-panel areas. Without the very heavy coat of insulating material that's sprayed on in the factory below and above the floor panels, all cars would make unbearable noise, so perhaps your model was not insulated properly.

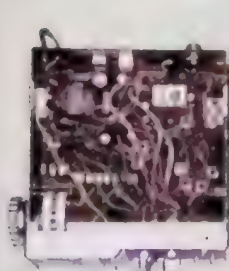
Each month in *Popular Science* Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Send it to: "Say, Smokey—" *Popular Science*, 380 Madison Ave., New York 10017. Questions cannot be answered by mail.

INTRODUCING THE WIRELESS

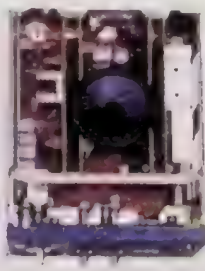


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*Because only Royce has the Wire-
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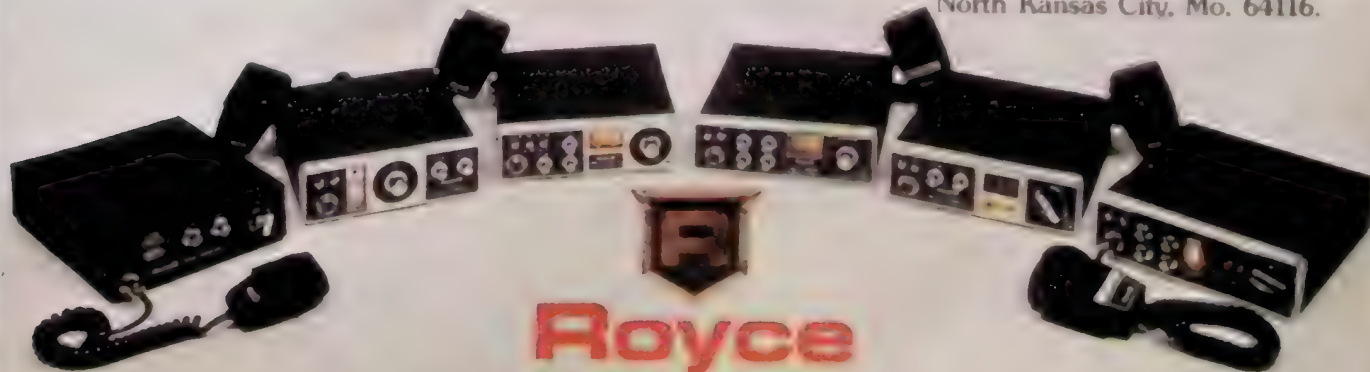
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Deck floats on concrete piers



As backyard sundeck or informal seating area, this sturdy wood platform rides high and dry

By AL LEES

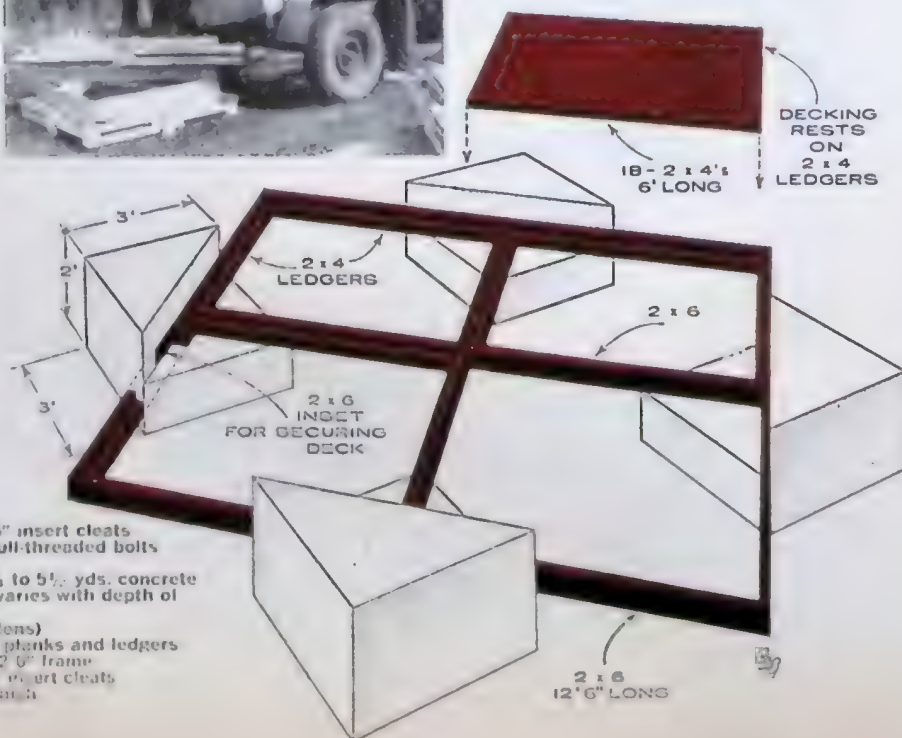
Working five evenings and one weekend, brothers Mick and Joe Hall of Vancouver, Wash., built this striking deck in Joe's backyard. It makes a clean play area for the kids, a cozy spot for sunbathing, and a serving center for outdoor parties.

What raises this deck above the ordinary are the solid-concrete piers it floats within. Though the Halls were new to concrete, they built the forms and did the pour themselves. A project on this scale

Continued



Filling forms is easy if you can reach them with load. New nationwide system rents you hitch/trailer to tow home readymix concrete; chemical additive prevents separation en route.

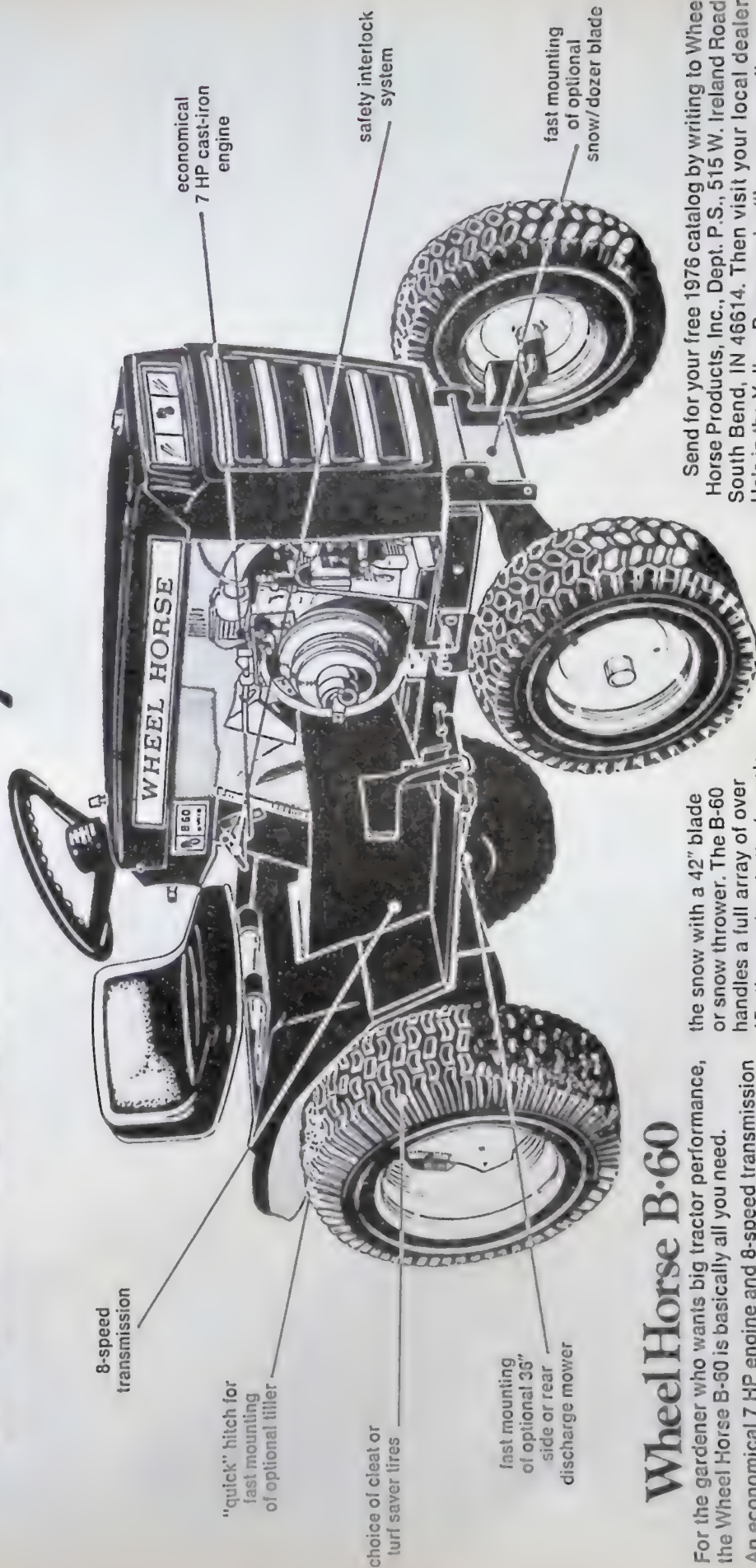


MATERIALS LIST

Concrete forms (4)
4 1/4" plywood, 1' x 4'4" (riser)
8 1/2" plywood, 2' x 3' (rear)
8 1/2" plywood, 1' x 3' (front)
12 2 x 4 x 4' braces (rear, top)
12 2 x 4 x 3'8" braces (rear)
24 2 x 4 x 2' braces (front)
12 2 x 4 x 3' braces (riser)
16 1 x 2 x 3' stakes
8 1 x 4 x 1'6" stakes

4 2 x 6 x 2'6" insert cleats
28 1/4" x 6" full-threaded bolts
Plus nails
For pour, 2 1/2 to 5 1/2 yds. concrete
(quantity varies with depth of foundation)
Deck (3 sections)
18 2 x 4 x 4' planks and ledgers
6 2 x 6 x 12'6" frame
4 2 x 6 x 8' insert cleats
Plus nails, finish

Basically, it's all the tractor you need.



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the snow with a 42" blade or snow thrower. The B-60 handles a full array of over 15 other optional attachments.

The B-60 also features a "quick" hitch for fast mounting of attachments. And has the same safety features found on our larger tractors.

Send for your free 1976 catalog by writing to Wheel Horse Products, Inc., Dept. P.S., 515 W. Ireland Road, South Bend, IN 46614. Then visit your local dealer. He's in the Yellow Pages under "lawnmowers".



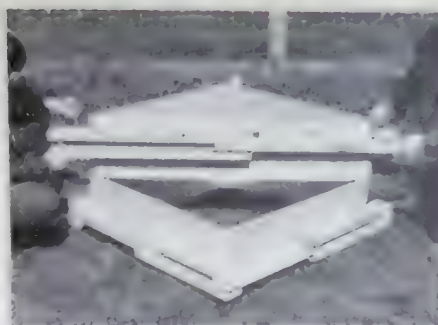
WHEEL HORSE
lawn & garden tractors

Floating deck

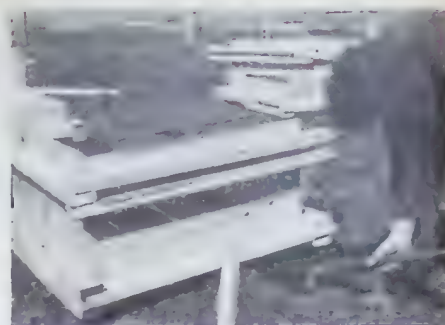
[Continued]

wouldn't be feasible with hand-mixed batches; yet the concrete volume isn't large enough to justify delivery by a readymix truck. What makes "in-between" projects like this feasible is a new network of concrete dealers that will rent to you a dump trailer—plus a hitch for your car—and sell you only the amount of premix you need. There's a chemical additive that keeps the mix from separating for as long as twenty miles towing time. The same additive guards against setting failures.

Once you've built your forms, take the dimensions to a U-Cart dealer, and he'll figure the quantity you'll need (you can order as little as $\frac{1}{4}$ yard). After your pour, rinse out the trailer and return it. One bonus of the system: You needn't kill yourself doing the whole job in a single go. Do as the Halls did, and save on form materials, as well. Build only a pair of forms and tow back enough concrete to fill them. Arrange to hold the trailer overnight; next day, strip the forms and set them up in their new locations before



1 Stepped forms have been drilled and now are secured with bolts. Single 2x4's project into pairs.



2 Level each form—after aligning with others and digging footing—by removing more dirt where form is high.



3 Stake in place, after again checking alignment, to prevent shift during pour. Drive stakes below top of form.



4 Fill halfway, then set cleat inside form (it should be short of 45° corners). Completed pour will bury it.



5 Let concrete settle half an hour, then screed it to remove excess and fill gaps. Work board back and forth.



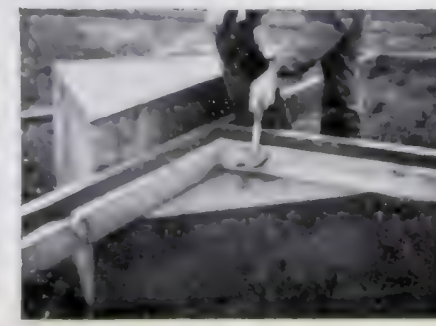
6 Tap form braces to bring cement to surface for smooth sides. Top brace should be lower here to close form gap.



7 Finish top face with magnesium float and trowel. Now let concrete set at least one full day undisturbed.



8 Unbolt form braces and remove a section at a time. Cleaned trailer has been kept overnight to get new load.



9 Assemble deck frame. Here ledgers are nailed to inner faces of frame after frame is nailed to pier inserts.



10 Open "planter" section at left requires no ledgers; they're to support 2x4 deck planks not yet added.

you drive off for a second batch.

Choose a site as level as possible—you'll need about 150 sq. ft. for a deck of the size shown. Stake out the location with string, then set the forms where you'll want the piers. Depending on local soil and frost, you'll want to dig a hole inside each form to a depth of from 6" to 3'. At the very least, you must remove all turf and loamy topsoil so you can pour on a firm, stable base.

The materials list specifies for four forms; halve it for two. The Halls braced the plywood panels with interlocking 2-by-4's designed for easy disassembly. Each form required two panels for the rear corner, two for the front, and one set diagonally to create the riser between the two levels. All 2-by-4 braces had extensions for bolting. Before you nail the plywood to the braces, lay it flat and arrange the braces to interlock. After assembling each form section, code it with a felt-tip pen.

Don't drill for the overlap bolts until you've set the sections in place and squared them. Insert bolts immediately after drilling to hold forms square. Coat the forms with a release agent—either a commercial type or your own mix (one-half diesel fuel and one-half hydraulic fluid)—and you're ready to pour. Just back the U-Cart trailer up to the form, use the hydraulic jack at front to tip the bed, and open the gate.

Pour until the larger bottom section of the form is full, then place the cleat insert in the form as shown. This should be redwood, cedar, or preservative-treated lumber; don't coat with release agent, as this cleat must remain embedded in the concrete as a nailing strip. Before you pour the second half, firmly tamp the concrete in the form with a shovel or 2-by-4, then let the form stand about five minutes so the concrete can settle and the special additive can work to draw out trapped air. Then follow photo-steps 5, 6, and 7.

Once all piers are poured, it's best to let them cure several days while you cut your deck members. Leave the 2-by-6's over-long, however; trim them after assembly within the piers.

The Halls got the design for their deck from a booklet titled "Concrete Ideas for Your Home." It offers 12 projects plus tips on form construction, tools, and how to estimate a pour. \$1 from U-Cart Concrete Systems (Box 1833, Vancouver, Wash. 98663), who will also direct you to a local dealer. **23**



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by INFLATE-A-BED

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HENRY MORGAN SAYS:

"Even if you don't know which end of a screwdriver you hold, you can learn to make money fixing appliances."

If you've seen this well-aged comic on television, you know I'm not in the business of fixing appliances. So what am I doing in an ad for an appliance repair course? It's simple: I got tired of laying out a sockfull of money every time something went wrong around the house. Then I came across an NRI ad and I thought, "Why not? I've spent a fortune on repairmen . . . if I'm too stupid to fix a toaster, this is the way to find out."

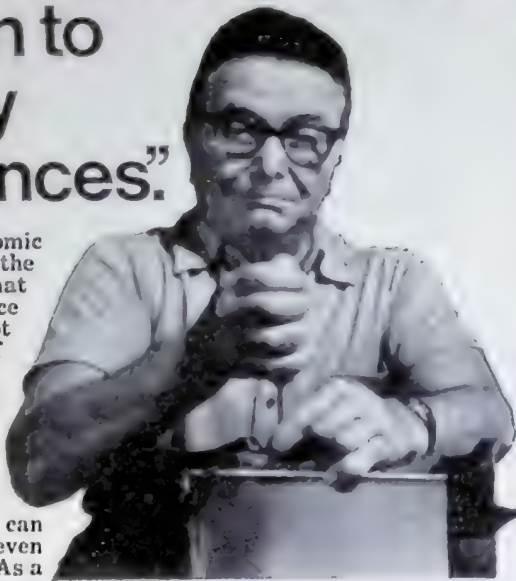
So I took the course and now I can fix my own appliances and I can even make money out of it if I want to. As a matter of fact, there's enough money in fixing these things, I'm tempted to quit show business and go straight.

Think I'm kidding about the money? Just check out the receipts on your last repair bills. And then ask anybody if they know a good reliable repairman. You'll find they're scarcer than doctors who make house calls. If there ever was a field crying for good men, this is it. Opportunity is knocking louder than my car's engine, and it could be knocking for you.

If you've ever toyed with the idea of making it on your own, with your own repair business . . . NRI has a low-cost, home study plan that really makes sense. You can hang in there with your present job while you're learning, and you'll find NRI's course is quick, easy, and cheap.

Let's say you have trouble just plugging in your electric shaver. You'd better start with the basics . . . and the NRI course starts right there. First they tell you what electricity is, and you can't get any more basic than that. They take you by the hand, step by step, as fast or as slow as you want to go. If you get an attack of the stupids, there's always an NRI expert waiting to give you a hand. They do everything but turn the pages for you.

Like I say, I took the course and it turned out to be even better than they



said it would be. Sure they pay me for writing this ad, but it ain't much, believe me. I could make more in a month by fixing things for the neighbors . . . and I'm not kidding. It's just that I believe in seeing guys make it on their own. If you follow the simple texts and the big pictures, you can be a technician in no time. They even send you a professional appliance tester with the course.

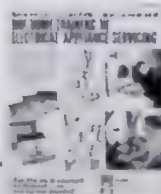
You don't have to stop with toasters and irons. They'll even show you how to repair air conditioners, refrigeration units, commercial appliances, power tools, and small gas engines. That's where the big money is.

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PS car test

[Continued from page 36]

• **CJ-7.** This Jeep is easy to work on. Oil changes are fast. The oil fill is up front—very easy to add oil without spillage. The filter can be removed easily from the top, and the dipstick is easy to remove and replace.

Doing tuneups on this peppy V8 mill is easy. No accessibility problems. Other maintenance items, changing coolant, light bulbs, belts, shocks, etc., offer no unusual problems.

The spare tire on the outside at the rear of the vehicle has a locking device to prevent theft. A scissor jack is provided to lift the vehicle.

The fusebox is under the dash, against the firewall. It could be a little easier to get at, but it's not too inaccessible.

• **Subaru.** All fluid levels are easy to check; a transparent master cylinder allows you to check the brake-fluid level without removing the cap.

All radiator and heater hoses are easily removed. However, both heater hoses connect to the heater core inside the engine compartment. And it's hard to remove them without dripping coolant on the carpeting.

Oil changes are easy. The filter can be screwed off from the top or bottom. The oil fill is unobstructed and easy to use without spillage. The spare tire is in the engine compartment, as is the scissor jack.

Checking and replacing fuses is easy: The fusebox is on top of the right front fender well.

A nice touch with the manual transmission is a dipstick. You can check the transmission fluid level without removing a plug, as you usually have to do with manual transmissions.

Tuneups and other basic maintenance operations offer no unusual problems.

POPULAR SCIENCE



For wet-season emergencies, back-up sump pump

The idea of depending on a sump pump that operates from your 110-volt house current could be all wet—literally. During a bad storm when you'll need the pump, there's likely to be a power outage.

That's the reason for this emergency sump pump. It operates from battery power (12 volts DC) and takes over if the water level reaches a point that indicates your primary pump is not doing the job. And that, of course, could happen if the water comes too fast or if there's a power failure.

This isn't a new idea, of course—you can buy a readymade system for \$350 to \$400. But, if you'd like to bail out your pocketbook as well as your basement, you can make one yourself for under \$90.

The pump I used, from Flotec, comes complete with an intake hose, strainer, battery clamps, and hook-up wire. It's self-priming and draws

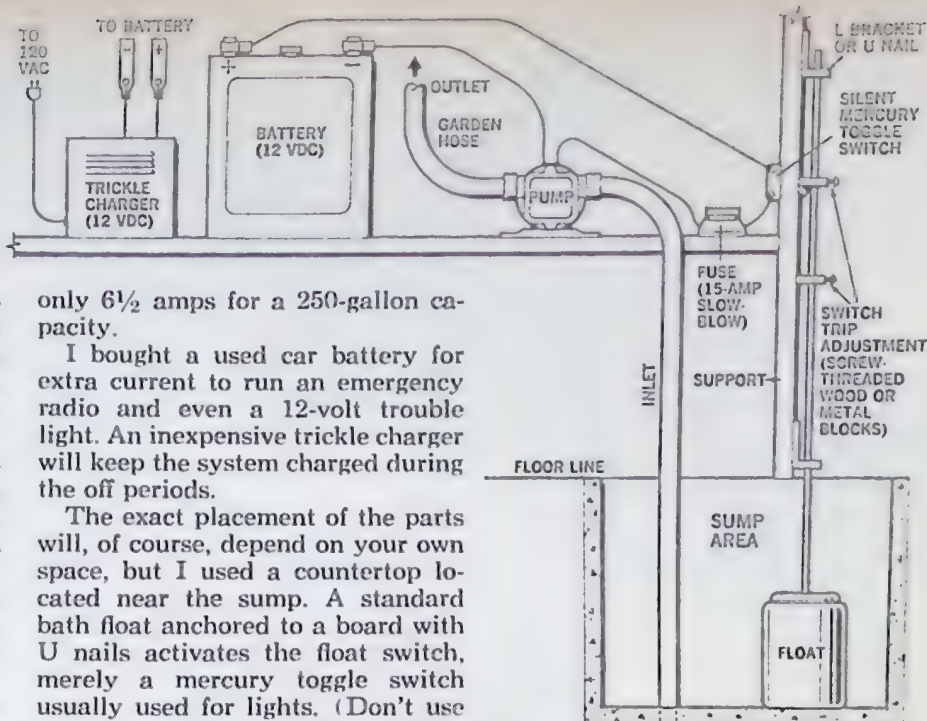
only 6½ amps for a 250-gallon capacity.

I bought a used car battery for extra current to run an emergency radio and even a 12-volt trouble light. An inexpensive trickle charger will keep the system charged during the off periods.

The exact placement of the parts will, of course, depend on your own space, but I used a countertop located near the sump. A standard bath float anchored to a board with U nails activates the float switch, merely a mercury toggle switch usually used for lights. (Don't use the snap-action type switch. They require too much pressure to actuate.)

The float should be adjusted to hang about ¼ to ½ inch higher than the float on your primary pump. This will insure that it will come on only after the latter has failed.

One final touch you can add to



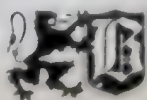
the system if you wish is a bell or remote light. Wired across the pump terminals, it will show the emergency pump is in use.

The pump is available for about \$45 from Flotec Inc., 14510 S. Carmanita Rd., Norwalk, Calif. 90650.
—George TenElshof



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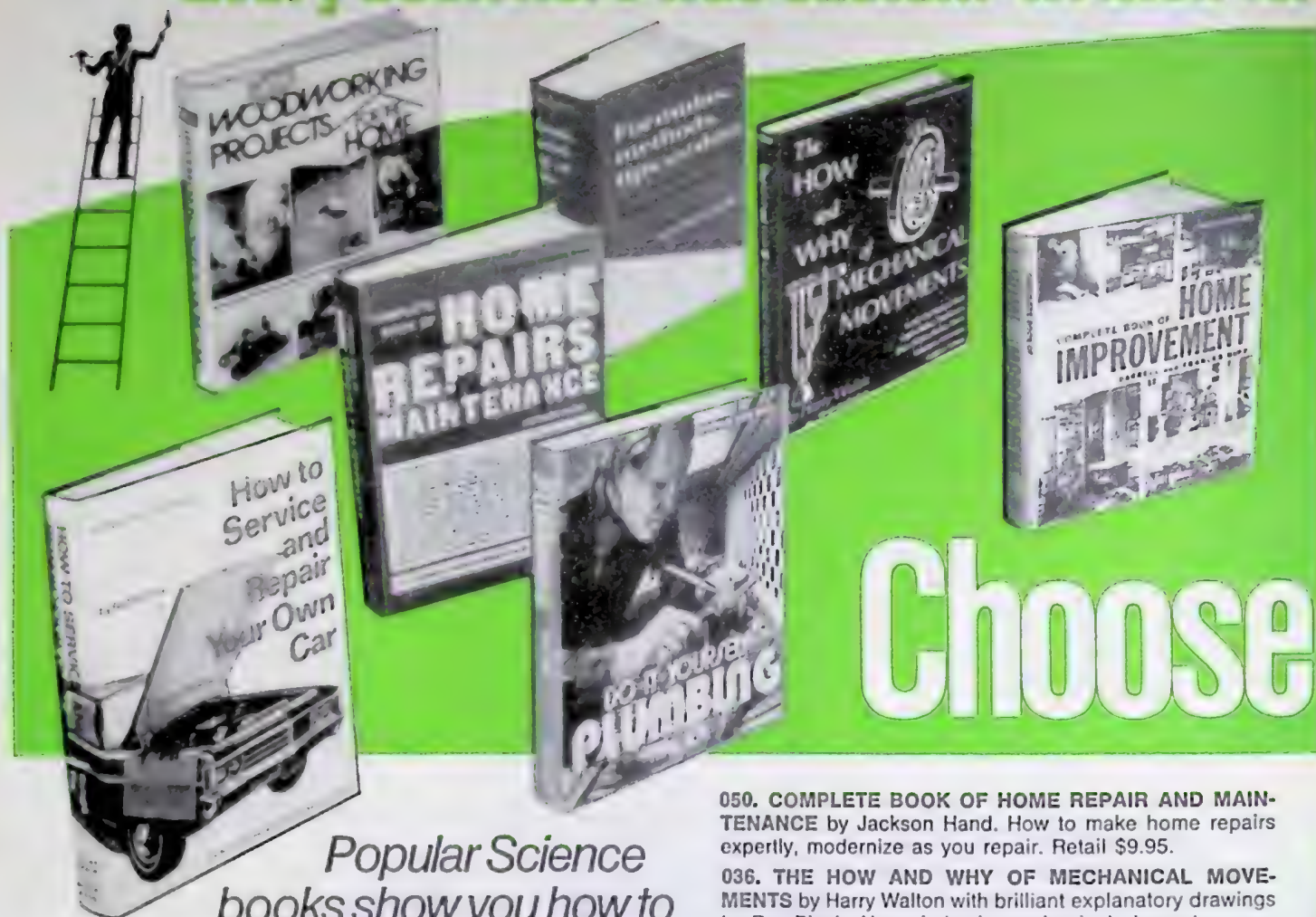
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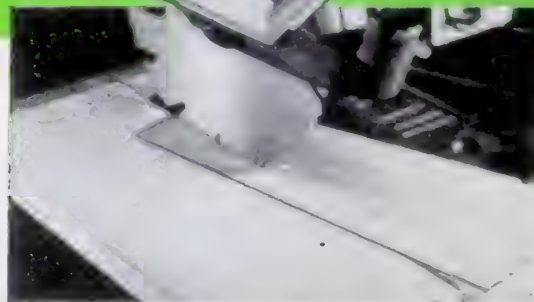


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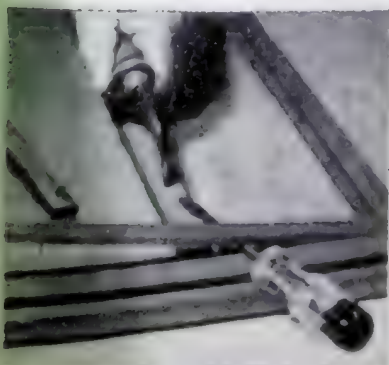
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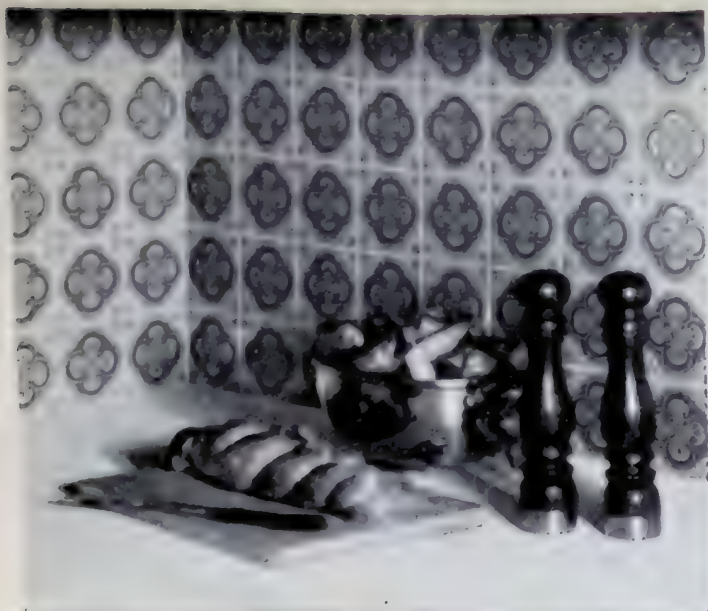
Simple homemade jig permits cutting tapered pieces on the radial arm saw.

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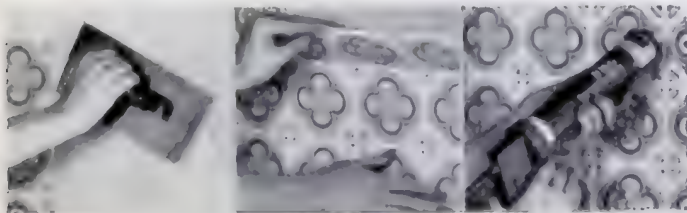
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Transaction telephone checks your credit fast

The Transaction II telephone, developed at Bell Labs in Holmdel, N.J., can run a quick credit check on a shopper while a salesperson wraps the purchase.

Like its predecessor, Transaction I, the newer model automatically dials the data center when a card is inserted. But with this model, the caller doesn't have to stand idly beside the unit, holding the receiver, waiting for the reply. He doesn't even pick up the receiver to place a call—he just presses the ON button, a feature called "hands-free operation."

Another new feature is a visual character display, which helps reduce errors that occur when the sales amount, credit-card number, or other data are entered manually.

Credit reports are given either by a computer-generated voice or a flashing light. Green means go. Yellow signals that something is amiss, and a clerk from the data center will then be connected with the salesperson or other caller.

A built-in speaker shuts off as soon as the data bank is reached. Muting this device prevents the red faces that might result if credit approval or check-verification requests were turned down audibly.

The Transaction II is designed for banks, car-rental agencies, retail stores, and merchants offering check-cashing courtesy cards. Any card encoded with a magnetic stripe can be handled. The first units were installed earlier this year.

Automatic dialing cards can bring help quickly in emergencies by summoning police, firemen, and security personnel.—Susan Bronson

Car racks

[Continued from page 71]

racks that put your two-wheeler on the roof, upside down. Loading is a bit inconvenient, and wheels should be rubber-banded to prevent spinning in the wind, with consequent bearing wear. Another roof and trunk mount uses rails and frame clamps. Sold by Bike Porter, Schwinn, and others, it holds two or four bikes.


Ski toting

Ski racks come in a boggling variety of systems for mounting the rack, holding the skis, and locking the rack and the skis. The Barrecrafters SR-90 holds skis on edge—an aerodynamic plus. Another good rack is the A&T #190 Zephyr. It features simple pegs and rubber straps, little wind resistance, and a low price. Best advice on ski racks: Put 'em on the roof if there's room. Use gutter mounts if you have good gutters. Or buy posts and rubber straps for a good boat or luggage carrier, and leave the basic rack on all year.

When the snow melts, many skiers become sailors. Some carry canoes, kayaks, and car-top sailboats. Everything we said about design and gutters and web straps applies. The rack and mounting must be strong. The boat must be tight to the rack, and for added insurance, secured directly to the car.

The foam-block canoe-pad system is sold by Grumman and several other firms. Four dense foam blocks fit over the gunwales, and the boat then rests upside down, directly on the roof, secured by gutter hooks and front and rear ties to the bumper.

Here's some final advice for selecting a rack: Look for self-locking nuts on any permanent fastening. On the other hand, insist on fittings that do *not* require tools for attaching the load to the rack. If you intend to remove the rack often, this no-tool feature should also include the method of attachment to the vehicle. Beware of holes and cavities. Uncapped tubing can whistle and howl at high-way speeds. Also, look for racks that are corrosion-resistant.

Locking racks are not foolproof: I know of none that'd slow a pro, or determined novice, more than a minute. Pay a bit more, nevertheless, for a locking rack—just for peace of mind during a noon lunch stop. And take those skis in, off the racks, at night. 

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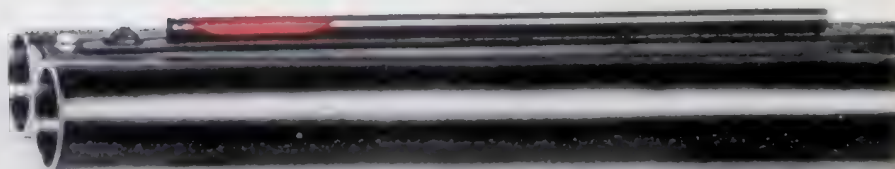
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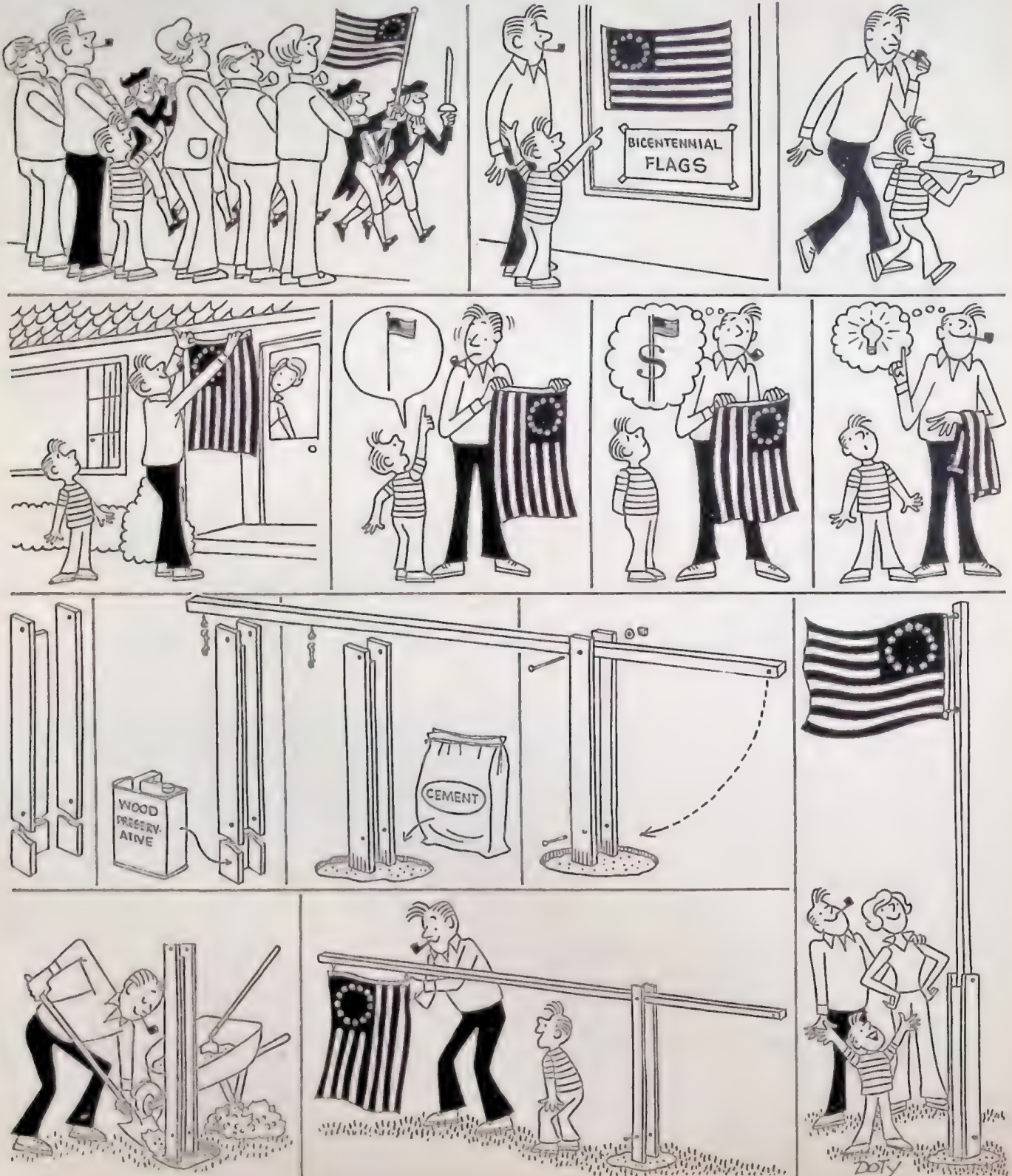
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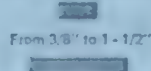


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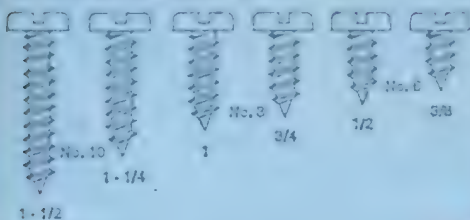
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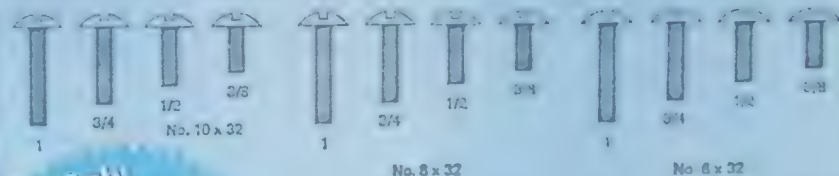
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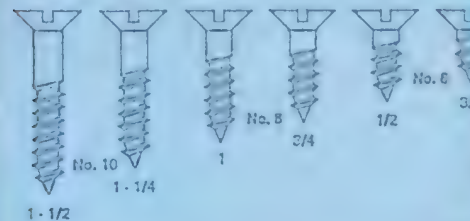
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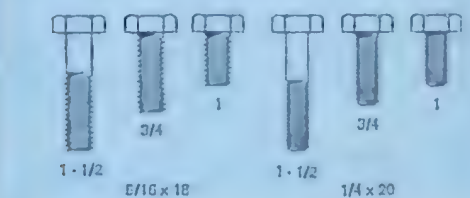
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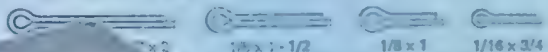
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New canoes

[Continued from page 89]

Sawyer charges \$200 more for Kevlar than for fiberglass.

How they handle

A canoe's shape determines how much fun or frustration you'll have. Ideally, a canoe should resist turning over, yet paddle with little effort; hold a straight course but maneuver quickly; stay dry in rough water, yet offer little wind resistance.

Warren Hastings of Camper Center in Tarrytown, N.Y., tells how canoe makers try to meet these often contradictory needs. "Some canoes," he explains, "have a separate or a molded-in keel to stiffen the bottom. A keel also improves tracking—an advantage for lake and flat-water use. But in white water a keel decreases maneuverability, increases draft, and may hang up on submerged objects. A better choice for a canoe used in both flat and white water is one with no keel, or one with a shallow shoe-keel or a V bottom. The V bottom is strong, tracks well, tends to be faster yet more maneuverable, but is slightly less stable than a flat bottom with keel." Curving the keel upward at each end to add "rocker" improves maneuverability, Hastings adds.

"A sharply pointed bow," he continues, "makes paddling easier, but it tends to dive into waves instead of lifting over them. Pointed but flared bows are a compromise. A low profile is less affected by wind, but the lesser freeboard increases chances of shipping water. Short decks or spray covers reduce the hazard.

"High seats are more comfortable, low seats more stable. Thwarts (cross-braces) strengthen the canoe, provide hand holds, serve as backrests, and provide lashing points for gear. One thwart should be at the balance point for portaging," Hastings advises.

My own brief paddles in the seven sample canoes confirm his experience of many years. Here's how I see them: Allagash and Old Town would be at home on a small lake or flat-water river, in the hands of careful canoeists who enjoy the look and feel of a traditional wood-frame canoe.

Alumacraft and Grumman keel models are good all-purpose canoes for casual car-topping in a variety of waters (but not in white waters), and are suitable for beginning and

Continued

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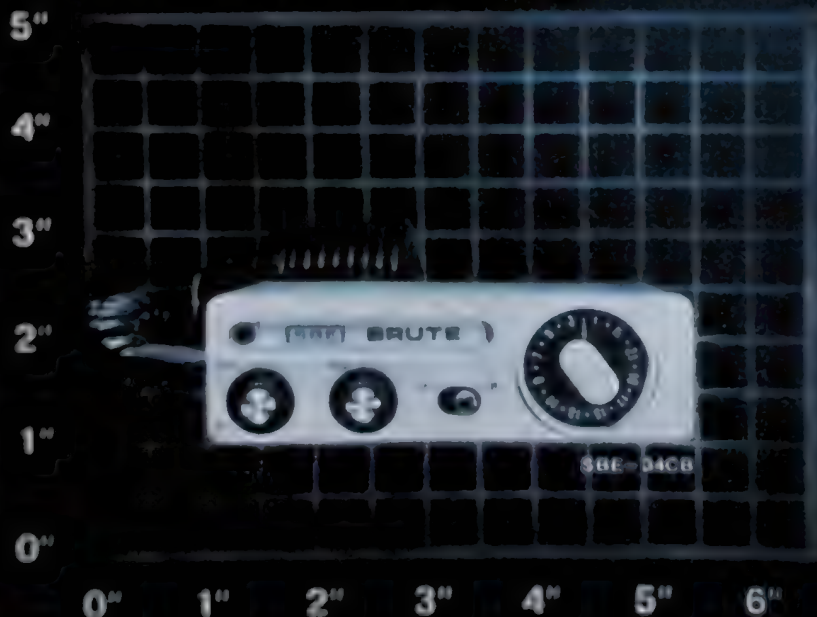
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New canoes

[Continued]

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Oxford (sold by Montgomery Ward) is ideal when kept at a lake-side dock for short paddles by youngsters or occasional canoeists who value safety more than speed or portability.

What else do you need?

A pair of paddles—and an extra one is wise. Most wood paddles cost \$14 to \$32, averaging about \$19, though Great World (250 Farms Village Rd., West Simsbury, Conn. 06092) carries first-rate Nova Scotia spruce paddles for only \$11. Fiberglass or ABS and aluminum paddles range from \$7 to \$24.

Buoyant vests for canoeing—essential for beginners, white-water runners, fishermen, campers, and racers alike—range from \$20 to \$30, depending on size. They're light and form-fitting to encourage full-time use.

For cartopping there's a set of four molded foam pads with tie-downs (about \$16) or racks that carry one canoe (\$20-29) or two (\$27-40). You can even pyramid three on the double rack if you're careful.

A handy accessory ashore is a portage yoke (\$15-34) or boat cart. The narrow cart pictured weighs eight pounds, carries 100, and costs \$48. The wide one weighs 13 pounds, handles 200, sells for \$75. Both fold and have removable wheels for stowing in a canoe. They're from Klepper Corp., 35 Union Square West, N.Y., N.Y.

These three accessories will get you started. Later you may want a pole (\$10-20), outboard-motor bracket (\$19-28), sail rig (\$200-400), spray cover (\$81-365), or other accessories. There are plenty. [E]

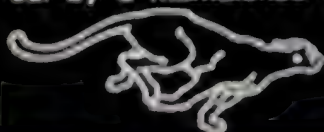


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For further reading
Rent-A-Canoe Directory. Addresses of 500 canoe renters in 42 U.S. states; six in Canada. Free: Grumman Boats, Marathon, N.Y. 13803.

Learn-To-Canoe Directory. Addresses of 300 sources of instruction in 42 states. Free: Grumman Boats.

Plans for PS Redwood Canoe. Plan 5511 includes 17"by-22" blueprint, article reprints, \$3.95 + 50¢ handling. Popular Science Plans, 360 Madison Ave., N.Y., N.Y. 10017.

The Canoe's Bible by Robert Douglas Mead (Doubleday & Co., 164pp., \$2.50). Illustrated. Broad coverage of canoes, paddling, tripping.

Back to Nature in Canoes, A Guide to American Waters by Rainer Esslen (Columbia Publishing Co., Frenchtown, N.J. 08825, 345 pp., \$6.95). Complete descriptions of 1000 places to canoe in continental U.S. Also addresses and phone numbers of 600 canoe liveries, Unique directory.

Canoe (1000 Shepard Rd., St. Paul, Minn. 55118; \$6 one yr., \$9 two yrs.). Official bi-monthly magazine of American Canoe Ass'n. Broad coverage of canoe and kayak products, techniques, and activities.

[Continued from page 81]

—to slow it down further. Then, at an altitude of less than one mile, it will fire its three terminal-descent engines to make a soft landing. Each is a cluster of 18 small nozzles, tilted outward so as not to contaminate the soil samples to be taken with their exhaust gases. Sensors on the lander's footpads cut off the engines for touchdown.

Computer and power systems

A Viking-lander report to Earth and an Earth command in response would take about 40 minutes (20 minutes each way). Since this would be prohibitively long for such purposes as guiding the scooping up of samples, a Viking lander is equipped to operate as long as 22 days automatically without contact with Earth.

It does so with a unique computer "brain" called the Guidance Control and Sequencing Computer (GCSC), an electronic wonder designed especially for the lander. This is possibly the most sophisticated single piece of equipment on the lander. Power for instruments

and heating comes from radioactive thermoelectric generators. They are superior to a solar-powered system because sunlight is only half as strong on Mars as on the Earth in daylight, and is nonexistent during the frigid Martian night, when the temperature may drop to -184°F .

Much additional valuable data about Mars will come from other experiments aboard the landers: Chemical analyses of Martian soil samples should confirm or refute, for example, current opinion of what gives Mars its ruddy hue. Rust-like compounds of iron could do it, in the latest view.

The lander will have an automatic weather station, including a wind indicator capable of recording Mars' fierce gales, whose wind speeds are estimated at 125 to 185 miles an hour.

Also aboard the lander will be a seismometer to detect and record "Marsquakes." The most spectacular signs of present or past volcanic activity on Mars are its huge volcanoes, rising up to 15 miles high. The largest one, Olympus

Mons, has no counterpart on Earth in size.

Finding life on Mars would, of course, be the jackpot. But even if we don't, that doesn't prove there isn't any. We might have picked the wrong places to try. Or our experiments might not have asked the right questions, for Mars' inhabitants may prove more exotic than we dreamed.

Vikings of the future will give us another try. They may land roving vehicles to seek more promising sites, and even robot craft to bring samples back to Earth, according to concepts already on the drawing boards.

And should, against all expectations, an intelligent Martian confront a Viking lander and analyze it in detail, he may well conclude that he is dealing with a pre+tv intelligent visitor from space. **E3**

For further reading

The Viking Mission to Mars, NASA publication SP-334, 1974.

Viking '76: The Search for Life on Mars, TRW Systems Group publication, 1976.

"Ninety Days on Mars," *Spaceflight*, July '75.

"Viking to Mars: The Mission Strategy," *Sky & Telescope*, July '75.




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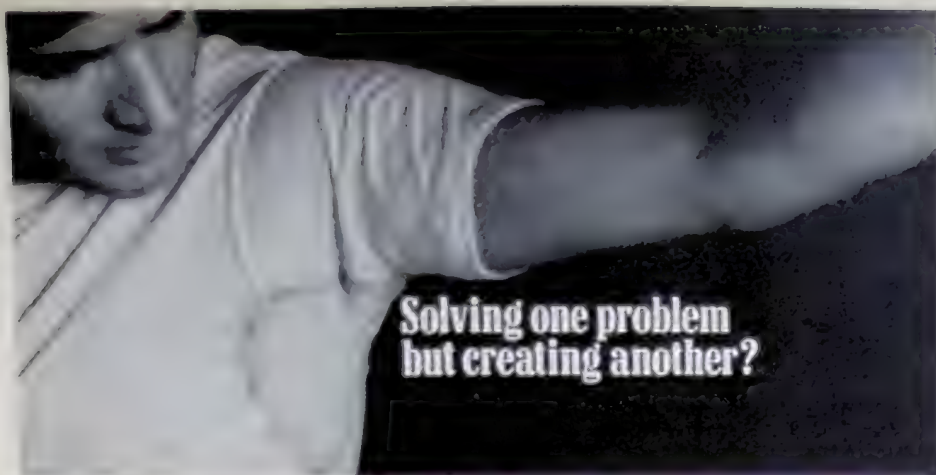
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Window into earth

[Continued from page 77]

mainly to narrow belts. If they were formed by the earth contracting, Wegener pointed out, they should be distributed uniformly.

- Geologic features and strata often jump oceans. One distinctive formation, for instance, is found both in South America and Africa. If brought together, the layers would line up "like torn pieces of a newspaper," as Wegener put it, with "the lines of print running smoothly across."

- Animals, both prehistoric and modern, bear a remarkable resemblance to each other the world around. Were all the continents once connected by huge land bridges? Not likely.

- Drain the water from the oceans and you'll find not simply low places, but craggy depths averaging 2½ miles. Continents would protrude like massive blocks of stone with relatively straight sides—and the contrast would be stark. Other scientists had already discovered that ocean beds are composed mainly of basaltic rock, and that continents are mainly granite-

like varieties that weigh only four-fifths as much. Wegener stepped beyond current thought, concluding that the continents not only float atop the oceanbed; they move about.

Such speculations were largely correct. But it wasn't until World War II that proof started coming in.

* * *

Water pressure on the hull reaches two tons per sq. in. as *Alvin* passes the 3000-meter (9,843-ft.) mark. So far, pilot Wilson has done all the work. Now, with only 460 meters to bottom, the two scientists begin testing equipment. Ballard turns on the CTSM sonar. Its one-second *whunggg*, like the song of a whale, is added to the whirr of the Brush recorder and a half-dozen humming electronic tones. He checks his cameras, recorders, data loggers, navigation system, external lights.

Suddenly the sonar sound changes; interspersed with the *whunggg* is a wobbly *bing*. There are 3420 meters of water above. After what seems like an endless descent, there is contact with the bottom of the sea.

* * *

Evidence of Wegener's old conti-

mental-drift theory strong enough to convince his skeptics developed only with technological advances in the fields of magnetism, underwater acoustics, and seismology. World War II spurred the generation of an airborne magnetometer, a device for measuring the intensity of a magnetic field; not incidentally, it was useful for submarine detection. After the war, when researchers refocused interest from subs to the earth, they found some surprises.

For example, when they examined igneous rocks around the British Isles, they found that the lines of force didn't match as they should. (As igneous rock cools, tiny bits of molten iron magnetically line up with the earth's poles.) Instead, the force-lines pointed nearly 30 degrees off. Conclusion: Either the poles had swung more than anyone had guessed, or the entire British Isles somehow had swiveled in its drift from the master continent Pangaea.

The next big step came in the late 1950's, when oceanographic vessels were called on by the Navy to use high-resolution, acoustic echo sounding to map the ocean floors. What emerged was a staggering picture of an alien land, with enormous deep gorges, odd, endless plains, and huge, mysterious, flat-topped mountains. Strangest of all was a series of ridges that snaked around the whole globe like a 46,500-mile scar.

About the same time, researchers using newly developed seismographs began to monitor earthquakes around the globe. By the 1960's, a pattern clearly emerged: Nine out of ten earthquakes strike along well-defined bands that follow not only known fault lines, but midocean ridges and deep-sea trenches. Why?

* * *

Bill Bryan peers down at the water as the camera cradle breaks the surface, and swings aboard the *Knorr*. Everything's intact, and that's a relief. On those first runs nothing seemed to go right. Bleepers wouldn't bleep; the \$900 cameras wouldn't work; and a \$1,000 compass was somehow crushed by the pressure. Bryan carries the cameras to the photo lab, then switches jobs. He begins preparing for a three-hour dredge run.

* * *

As evidence of plate movement accumulated, a pattern gradually formed, electrifying in implication, awesome in magnitude. Not only are the plates skating across the

Continued

surface of the earth, but new crustal material is constantly being formed. In the Mid-Atlantic Ridge, for example, the plate carrying the Americas is gradually pulling away from Europe and Africa at about an inch a year. Where the rip occurs—in what is known as a “spreading center”—“the earth sends up its equivalent of blood in the form of molten lava,” as Ballard puts it. “It coagulates, scabs, and heals the wound.” It welds itself solid, then rips again, cementing and tearing again and again.

If crustal material is being added in one place, then it must be destroyed in another, or the earth would grow larger. What happens when plates meet head on? One simply rides over the other, forcing it downward into the earth's interior, eventually to break up and melt.

Such zones are those mysterious deep-ocean trenches discovered by acoustic techniques and spotlighted by seismographs. The deep-throated earthquakes of these regions are simply rumblings of the mantle digesting another hunk of plate. The continents themselves are too light to sink into the trenches, but they can weld together, often forming mountains or fragmenting.

Where two plates rub against each other in a boundary of translation, the result is shallow, devastating earthquakes, and occasionally, mountain-building as well. Such a boundary is the San Andreas fault, with Los Angeles sitting on one plate moving north, and San Francisco on another one, feeling it grind by.

* * *

The sonar-bing volume intensifies, and Ballard strains to see through a port. According to the chart, at 3400 meters the sub should meet the canyon wall. “I’ll level off at thirty-four fifty,” says the pilot, “and drive over to the wall. Okay . . . now.” He flips a covered switch, and from *Alvin’s* bottom drop two 230-pound stacks of steel plates. The vessel abruptly slows, shudders, bobs a bit as Wilson adjusts the variable ballast by pumping seawater into small titanium tanks, and settles like a slightly overloaded elevator. “*Lulu*, we have contact. Driving to the wall now.” He swivels her propeller, and *Alvin* purrs westward.

At 30 meters Ballard’s high-frequency altimeter detects the rising wall. “That’s the time the pilot relaxes,” Ballard had said the night before, “and we tense. We’re looking for the wall, and we’re wondering what it’s going to look like.



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Suddenly, through the murk, in the soft, greenish light of a thallium-iodide lamp on the submarine’s top, looms the wall.

* * *

Men first looked at a deep-ocean divergence zone in the summer of 1974. In a project called Famous (French-American Mid-Ocean Undersea Study), Ballard and dozens of other scientists mapped, scanned, listened to, sampled, and then explored a 60-mile square southwest of the Azores.

They found that the rift—a mile-deep canyon in the midst of the world’s largest mountain range, the Mid-Atlantic—is a series of cracks in a zone three to thirty miles wide. At the bottom, it narrows to a floor about two miles across. They saw fifteen-foot “haystacks” and bulbous “pillows” and “toothpaste” lava formations squeezed from ocean-floor vents at 2200° F. They found that the farther out from the center they sampled, the older the rocks were—the more sea-worn and manganese-covered—as theory predicted. They detected an average of 12 micro-earthquakes a day. They found fissures and faults only a

few hundred feet long, and others dozens of miles; some an inch wide, others fifty yards. They found that the youngest rock is more magnetic than expected, but nobody has yet figured out why.

* * *

“Good, good,” mumbles Ballard, as the wall approaches through the mist. It’s a rugged slope, canting upwards at 72°, powdered with silt and the dust of tiny dead sea creatures. Scattered all about are corals, sea cucumbers, and sponges. Every so often a fish flits by—brightly colored despite the blackness. Trails wind here and there, some, significantly, abruptly cut off, erased by silt slides.

The wall is too steep to land on, but Wilson noses the sub up to it, gently bumps to a stop, and turns off the sonar. “*Lulu*, we’ve landed,” he says. “How close are we?”

“Only about 50 meters off,” answers the catamaran above.

The cliff drops like a road cut, exposing eons of history. Ballard decides to sample it, and the pilot reaches out with *Alvin’s* claw, trying to pick up a piece. A torrent of silt slides down the cliffside. In 10 minutes the dust has settled.

Continued

but the rock won't budge. He tries another spot, and another. Finally he breaks off a hunk of ebony basalt the size of a breadloaf and drops it into a numbered tray on *Alvin's* lazy susan. "That's a relief," says Ballard. The worry is always there that the cliff-face will be so massive that samples can't be taken—a situation arising during Famous dives.

Now it's work. The sub sets off on a grid pattern that will last four hours: across the cliff face, up 20 meters, back across, up—with an occasional stop for samples. "All the anxiety, all the adrenalin, has left," says Ballard. "The excitement now is what's next. You're doing what you do best, and you feel good."

* * *

The Cayman Trough borders the north edge of the Caribbean Plate, a relatively small one as plates go—a rough oval that takes in Jamaica, a slice of South America, and much of Central America. Its border jags through Guatemala City.

To the north, the American Plate is plodding westward. But the Caribbean Plate can't ride along; its western edge is resting against the Cocos Plate, out in the Pacific. The American plate simply gnashes past. What results is a transform fault, the deep-sea equivalent of the San Andreas fault zone.

Of particular interest to geophysicists is a dog leg, a 90-mile Z-shaped jog in the fault line. It appears to be not only a translation boundary, but a spreading center as well, a miniature Mid-Atlantic Trench. In theory, then, somewhere in the neighborhood should be fresh lava.

* * *

It's eight p.m., and Bill Bryan is tired. So far today he's supervised a camera run, watched over a dredge run, and directed the day's retrieval of micro-earthquake-sensing sonobuoys. (Earthquakes average one every other day, project seismologist Ken MacDonald discovered. On February 20, he recorded a major quake—magnitude 6—about 200 miles east of the study area, along the same Montague Fault as the Guatemala quake. "No large earthquakes have occurred in this section in over 20 years," he reported. "The plates may have been stuck here and are now breaking loose. There may be more to come.")

Now, at the end of the second dredge run, after a total of six hours before the screen watching those blips, Bryan's still busy.

He sits here in the main lab, a meter registering tension on his left, the navigation screen on his right, a telephone in his hand. He watches the screen and alternately directs Capt. Emerson Hiller on the ship's course and the winch operator on playing the four-mile-long cable. The combination cable and dredge weighs about 6500 pounds, and when the meter begins to register 8000 or so, Bryan knows he's collecting rocks.

* * *

The two high spots in the voyage came early, and each was more or less an accident. The first was the discovery of that massive wall of rock.

The second break came when the *Knorr* was steaming to its location. The scientists' spirits were low: the weather was rotten, the cameras wouldn't work right, nearly all activities were delayed, and no data were coming in. The ship, as Bill Bryan puts it, "was just moping around, waiting for things to be fixed. We were sick of sunbathing and Ping-Pong tournaments.

"So we did a blind lowering of the camera just to see the bottom, because nobody had ever seen it here before. Well, the camera got trapped. We jockeyed the ship around and finally got it loose and hauled it up. No pictures—but something infinitely happier: The camera frame was stuffed full of very fresh pillow lava. Can you imagine? We were looking for some evidence of volcanism, *anything*, and we came up with a camera full of it."

The fresh lava was the first proof of their theory, that the dog leg is a spreading center.

And that lava *is* fresh. One morning, right after a dredge had dumped its contents on the deck, I picked up a piece of basalt the size and shape of a croquette. I held it in my hand and it jumped. *Jumped*, cracked, and split into three pieces.

"That proves it's fresh," said Bryan. "The pressure down there is three or four tons per square inch. Over a period of time, the gas diffuses into the water, but this rock doesn't seem to have degassed at all. Until now."

How fresh is it? Nobody will

Continued

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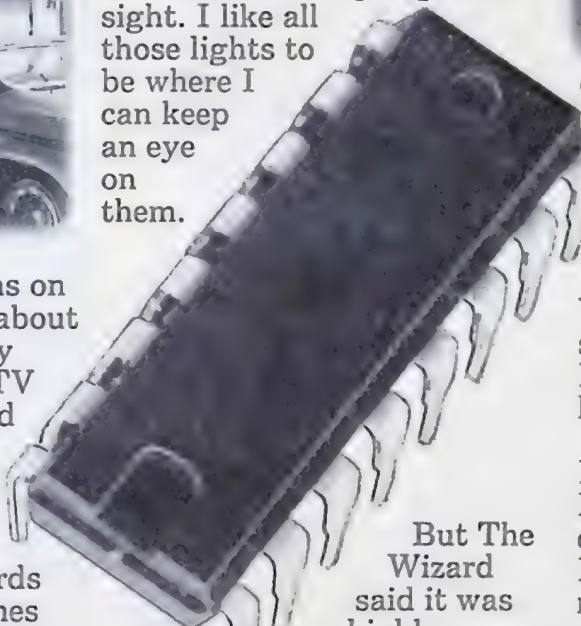
The Wizard kept putting off buying a CB radio because the ones that met his high standards cost too much and the ones he could afford weren't sophisticated enough. The



Wiz is a stickler for electronic perfection.

But, one day, The Wizard gave me a call and told me to come over because he'd finally discovered a CB good enough for him. I figured if it was good enough for The Wiz, it must be a honey.

When I got there, I found out he had a Midland 830 just like mine! I got it because it was the easiest to use. The lighted S/RFO meter, TX light and big, easy-to-read lighted channel selector are on top, right in sight. I like all those lights to be where I can keep an eye on them.

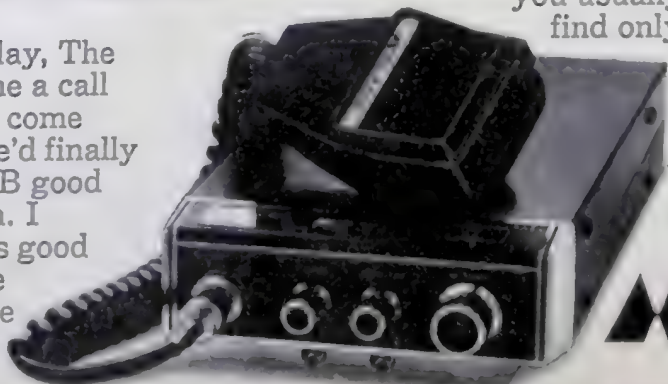


But The Wizard said it was a highly advanced piece of equipment.

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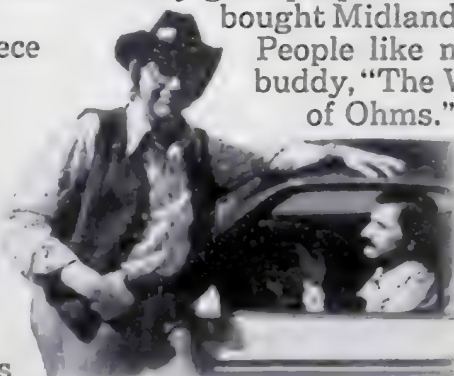
you usually find only



on more expensive units, like external CB and PA switches which let you switch CB reception to a speaker outside your car or use your CB as a public address system. The Wizard likes all these sophisticated components. But I still like the little lights on top.

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Window into earth

(Continued)

say before the lab tests, but from what he's seen, Ballard is convinced that "the place is jumping"—with vibrations and shudders and tremors and probably even lava.

"Remember those 'animal' trails that were obliterated? The tracks were cut by rock slides. And we saw one block half the size of this room that had skidded down a slope. The marks were still behind it. Why landslides? Simple: the ground moves."

Back in the laboratory over the next year, the scientists will analyze their data to refine what they know and to try to answer the remaining puzzling questions. For example, why do the plates move? Volcanologists talk about mysterious plumes of lava forcing themselves up through the spreading centers, forming island chains and pushing up plate edges just enough so they slide away. But few are completely satisfied with the explanation. "The basic geometry is too simple," says Bryan. "It works only on a perfect sphere, and the earth is elliptical."

And questions more practical may be answered: How are minerals deposited, and where? Where is the oil? And how can earthquakes be predicted?

* * *

The time is 5:43 p.m. To break surface in daylight, *Alvin* must soon begin its ascent. "You're tired, your legs have cramped, the temperature's dropped, your bladder's full, and you've got a headache," says Ballard. "You've got a basketful of goodies and a trunkload of tape, and you'd just as soon see that surface glowing overhead."

The pilot drops the remaining weights, and the sub bounds upward. "You know, without *Alvin*, studying the plates would be like examining the moon with a telescope, or doing geology in the Rockies from a helicopter—not being permitted to walk the outcrop," says Ballard. Then he removes the tape cassette he's been recording on and, instead, inserts one from his flight bag.

Work is finished for now. The submersible rises. And the sphere is filled with the sound of Johnny Cash. **EB**

For further reading

Continents in Motion—The New Earth Debate, by Walter Sullivan, McGraw-Hill Book Company, New York, 1974.

The Restless Earth—A Report on the New Geology, by Nigel Calder, The Viking Press, New York, 1972.

"Plate Tectonics—A Startling New View of Our Turbulent Earth," by John Speicher, PS, June '72.

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[Continued from page 56]

137mm (5½ in.) focal journey the image must take between lens and film pack, by way of two mirrors.

I found the camera comfortable and natural to hold, easy to use. Not everyone agrees. Some—per- versely, perhaps—want to wear the wrist strap on the right hand, where it blocks the camera's print-exit slot. A more serious objection is weight. The EK 4 weighs 26.7 oz., the EK 6 29.1 oz.—close to twice the 16 oz. of Polaroid's Pronto. In addition, the Pronto scores very high in ease of handling.

The Pronto is, of course, the camera with which these two Kodaks must be compared. Its price, \$66, compares with the EK 4's \$53.50 and the EK 6's \$69.50. It would be unfair to compare the Kodaks with other, much more costly SX-70 cameras—cameras of an unsurpassed design elegance, with expensive glass lenses and more flexible exposure systems.

Zooming circle

The Kodaks offer a small one-up in focusing for portraits. A "zooming circle" in the viewfinder changes in size as you focus by moving a slide at the front of the camera. When the circle exactly encloses the head of an adult subject, the camera is focused.

Both Kodak and Polaroid offer sophisticated automatic exposure control. In both, even with flash, a silicon photocell reads the light reflected from the subject, to determine exposure.

Both systems offer three-element coated plastic lenses. The Pronto lens has a continuous aperture range, from f/9.4 to f/22, and a shutter-speed range from one second to 1/125. Kodak offers just two lens openings, f/11 and f/16, with a continuous shutter-speed range from 1/20 second to 1/300.

How do they compare?

Finally, the "bottom line." What are the Kodak pictures like? How do they compare with Polaroid's?

Here's one verdict, based on a study of hundreds of photographs taken by the PS staff:

- **Color realism:** Unquestionably, Kodak wins here. Grasses are grass-green, skies sky-blue (instead of navy blue), yellows yellow. Our Polaroid pictures tended to be tinged with magenta—pleasingly sometimes, if not realistically.

- **Picture sharpness:** Pronto and Kodak pictures were comparable

Continued



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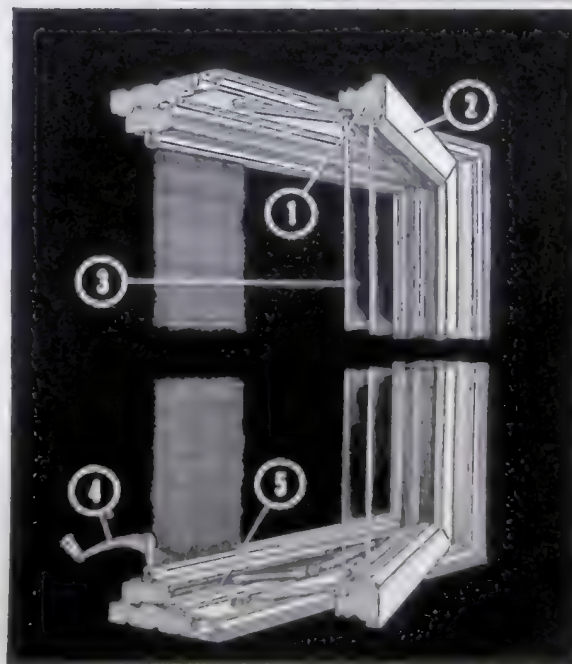
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[Continued]

here, we thought—or so close that steadiness of holding and accuracy of focus were far more important.

• *The finishes:* Polaroid prints have a glossy finish. Kodak's come in a "Satinluxe" finish. I dislike "silk" finishes that obscure print detail—but here, I think, Kodak has achieved something: a pattern

exposure of his face. A white shirt on Dad may cause underexposure, while Junior's blue denim jacket (if he hasn't bleached it yet) may tell the camera to overexpose Junior's face.

Lighten/darken controls on the cameras of both systems make possible some compensation for such problems. Polaroid offers a three-

with Polaroid's top-of-the-line SX-70 cameras? Yes. Due at the end of the year is the EK 8, a folding instant-picture camera, to be manufactured in Germany.

And unquestionably, Kodak intends to compete in other ways. Much of Kodak's revenues comes from licensing its developments, and there is little doubt that other manufacturers will soon be producing cameras for Kodak instant-picture films.

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that is almost invisible but that stubbornly resists fingerprints.

• *The percentages:* Both systems, we are convinced, are capable of yielding excellent pictures. But not every time, and not with the same consistency, say, of an Instamatic camera using color-negative film. The primary reason, of course, is that there is virtually no exposure latitude in an instant-picture system: The exposure must be accurate enough to produce a pleasing finished print. With a negative, an inaccurate exposure can, within limits, be compensated for in the final print.

Prints from both Polaroid and Kodak systems tend inherently to be contrasty—a slight shadow on one side of your subject's face will be deeper in the picture. It's even worse in a contrasty picture-taking situation—in bright sunlight, for example, with accompanying dark shadows. Fill-in flash becomes important.

(The Kodak flash, incidentally, is the eight-shot Flipflash, which Kodak also uses for its Instamatic cameras. Polaroid uses the 10-shot Flashbar.)

The darkness of your subject's clothes will have an effect on the

stop adjustment, Kodak two stops.

But this, of course, is *after* you have photographed the horse leaving the barn. At 70 or 75 cents a print, plus flash cost, bracketing in on correct exposure is expensive.

Still, with instant-picture photography, you know when you have the picture (you don't risk the trauma of a blank roll of film coming back from the processor), and there's the great pleasure on special occasions of having it there and then.

And when you do take that fantastic picture that everyone wants copies of, Kodak, like Polaroid, offers a print copying and enlargement service.

Coming up: more competition

Does Kodak intend to compete

One need not weep for Polaroid, a huge and enormously profitable corporation. Besides its SX-70 system, there is its older pack-film system—still going strong side by side with SX-70 and now fortified by the beautiful new Polacolor 2 film. And, of course, Polaroid has its technical and professional divisions that offer unique services.

Still, one can sympathize with the wounded cry of Dr. Edwin H. Land, creator of the Polaroid Land cameras: "This is our very soul that we are involved in . . . For them, it's just another field."

"Just another field," or not, Kodak is now in the instant-picture battle; and while the competition may mean spilled blood, it should also mean more and better instant pictures.

49

You may throw your aspirin away, once you've discovered...

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The human body is the most fabulous machine of all. Built into it are wondrous healing mechanisms which man has never been able to duplicate in the laboratory. For reasons not yet completely understood, Acupressure (in a way very similar to its cousin, Acupuncture) seems to be a way to "trigger" these miraculous healing mechanisms; and bring soothing relief as the healing process takes over, doing those things for the body which only the body can do for itself.

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Even when you're not in pain. Even when you're not in pain, it can be a great help to relieve tension and simply to relax. To put your whole body at ease (even get you to sleep without pills). More effective... and of course more convenient than a backrub because you don't need anybody but yourself.

Acupressure is proven effective in achieving a dynamic sex life. Many women have found it can correct irregular menstruation, control the unpleasant aspects of menopause, overcome frigidity, even work wonders in bust development. Many men have found it can correct impot-

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Shower-cabana

[Continued from page 85]

es on the upper section must be in exact vertical alignment.

The simplest way to make the half-lap joints is with a series of kerfs cut to a depth equal to half the thickness of the 2-by-4's. Be sure to make these cuts at the required angle. Clear out waste with a chisel and assemble the H with 1½" galvanized nails.

Place this assembly onto the deck so it rests on the flanges. When in alignment, strike a blow with a rubber mallet over each flange location. This will leave an imprint on the lower face of the roof assembly indicating where to locate the upper flanges.

The holes in the rafters are decorative, to give the roof framing a lighter look. Those up to 3" diameter can be bored with an expansion bit. Cut out the larger ones with a saber saw.

PVC framing

Although PVC pipe is strong, you'll have to insert closet poles in the two front supports. This permits drawing up the through bolts (when attaching the hoops) without deflecting the pipe ends out of round. Full-length plugs are also necessary to provide purchase for the door-frame screws. Use 1½" poles and wrap some tape around the short plugs to hold them in place if the fit isn't snug.

Most adapters for PVC have a shoulder at 1" depth, in which case the framing pipes should be cut to 74 inches in length. This leaves exactly six feet of pipe exposed after it's seated in the adapters. The hoops, when resting against the rims of the adapters, should be spaced six feet apart, outside to outside.

Place the hoops between the vertical pipes and bore through holes for ¼" round-head bolts. If you rub some soap on the outside ends of the pipes they'll come apart readily. This should be done particularly on the upper ends because the roof assembly will have to be removed (after side panels are secured) for installing the roof panels. The pipe ends need not be cemented into the adapters. Adjust pipe length if necessary.

You'll need seven 6' lengths of Filon Stripe panels for the walls and door. Minimize waste by obtaining three 12-foot lengths and one 8-footer. See "How to Work with FRP Panels" [PS, June] for cutting tips.

[Continued]

Putting it all together

Attach the two front panels first, using a few small C-clamps to hold them in place while holes for the screws are drilled to coincide with the holes in the hoops.

You can't see through the colored stripe section very well unless you resort to a simple trick: Have a helper hold a flashlight against the hole on the outside. Use a $\frac{1}{4}$ " bit and drill a screw clearance hole through the panel and wood, but don't penetrate the aluminum. Otherwise, the self-tappers won't grab.

This lighting trick saves a step. The alternative would be to drill from the outside of the hoop with a $\frac{3}{16}$ " bit, then redrill from the inside with the larger-clearance hole bit. Note that oversize clearance holes will be necessary in the panels at those junctures where the nuts and bolts that secure the hoops protrude.

Install the second pair of panels with a one-rib overlap, and the same with the last two panels. The Filon screws are long and project a half inch on the outside of the hoop, but they don't detract from appearance. Don't cut off the ends or you'll have rust problems.

A $\frac{3}{16}$ "-by- $\frac{1}{2}$ " bolt with nut and metal/neoprene washers on both sides is used halfway up each panel where it overlaps another to close the joint. A short length of dowel, $\frac{1}{2}$ "-by- $\frac{3}{4}$ ", with a hole bored through the center, is used as a standoff support at midpoint where the two front panels adjoin the PVC. Wood screws are used here. Note that neoprene-surface washers must always be used against a panel surface. They're available as accessories.

Raising the roof

Filon horizontal redwood strips shaped to conform to the corrugations of the Clearlite panels are nailed on top of each of the five rafters. The best way to align them accurately is to lay them on the beams, then place the panel over them and shift each strip as required until they line up.

The roof consists of two pieces of Clearlite cut from a $51\frac{1}{4}$ "-by-10' panel. This results in a 12-corrugation overlap. If 26"-wide panels are available to you, you can use three lengths with a one-corrugation overlap.

Special aluminum nails with built-in neoprene washers are used

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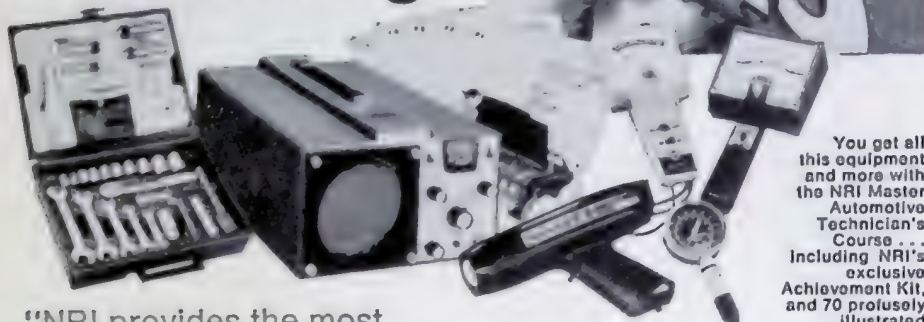
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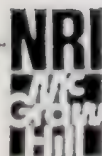
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Shower-cabana

[Continued]

to attach the roof panels. You can use the nails as is, but in areas subject to high winds it is advisable to make a substitution: Remove the somewhat small neoprene washer and insert one of the larger accessory washers in its place.

Note when you buy the Clearlite panel that it has a label. Do not remove this label until the panel is installed. The label indicates the weather side of the panel. When the panel is cut, be sure to mark the weather side on the cut-off piece.

The door is assembled as shown in the drawing and photographs. The wood parts of the door (as well as the roof framing) can be painted if desired (we matched one of our Filon stripes), but the deck and bench are left as they are.

Add the plumbing

See photos for details on installing the mixing faucet on a wood support. You tap into your home's water supply and run 1/2" CPVC pipe to the shower as shown in "Extend Your Plumbing with Plastic Pipe," PS, May '73. You'll want to include a stop and waste valve for draining the lines for winter. For the dry well, dig a hole three feet in diameter, about four feet deep, where the shower will be located. Fill the hole with crushed rock. The top few inches can be firmly tamped gravel. **[E3]**

Materials list

Wolmanized lumber

- 1 pc. 1" x 6" x 8'
- 10 pcs. 2" x 4" x 12'
- 4 pcs. 2" x 6" x 12'

Filon panels and accessories

- 7 pcs. 6' Filon Stripes
- 1 pc. 51 3/4" x 10' Clearlite panel
- 8 pcs. 6' Carousal redwood closure strips (ribbed)
- 5 pcs. 6' Horizontal redwood strips (corrugated)
- 1 box hex head self-capping screws (Filon)

1 box weatherproof nails (Filon)

Misc. lumber

- 3 pcs. 1 1/4" x 6' closet pole
- 4 pcs. 1" x 2" x 6' (redwood or Wolmanized)
- 2 pcs. 1/2" x 3/4" x 26" (redwood or Wolmanized)
- 2 pcs. 1/4" x 3/4" x 14" (redwood or Wolmanized)
- 2 pcs. 1 1/2" x 3/4" x 6' (redwood, Wolmanized, or hardwood)

Aluminum

- 8 pcs. 1/2" x 1" x 6' aluminum bar stock
- 3 pcs. 1/16" x 1" x 1" aluminum angle

Frame accessories

- 12 pcs. 1" galvanized flanges
- 12 pcs. 1" PVC adapters
- 6 pcs. 1" x 7/4" PVC pipe

Miscellaneous

- 2 2" brass butt hinges
- 1 1/2" and 3" hot-dipped galvanized nails
- Rivets, screws, bolts, nuts, washers (nonrusting)

Plumbing

- Water-mixing faucet
- Shower head
- Soap dish
- Shower curtain and rod
- CPVC 1/2" pipe and fittings as required
- CPVC primer and solvent



Boat ladder hugs the hull

Clever's the word for the new Hull-hugger marine ladder. Foam-filled aluminum links pivot on hollow aluminum rungs, permitting the ladder to fold compactly for storage or, when open, hug the hull while affording a safe standoff for the feet of the climber. The links, of course, offer handholds. Vinyl strips around them protect the hull against marring.

The lightweight ladder floats and, says the maker (Sea-Link, Inc., 225 N. Sunnybank, St. Joseph, Mich. 49085), will even support a swimmer in an emergency.

The six-step (five-link, 6½-lb.) model shown sells for \$79.95; the four-step (three-link, four lb.) model for \$54.95.—E. H. Ortner

Fix your toilet for the last time.



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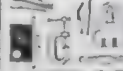
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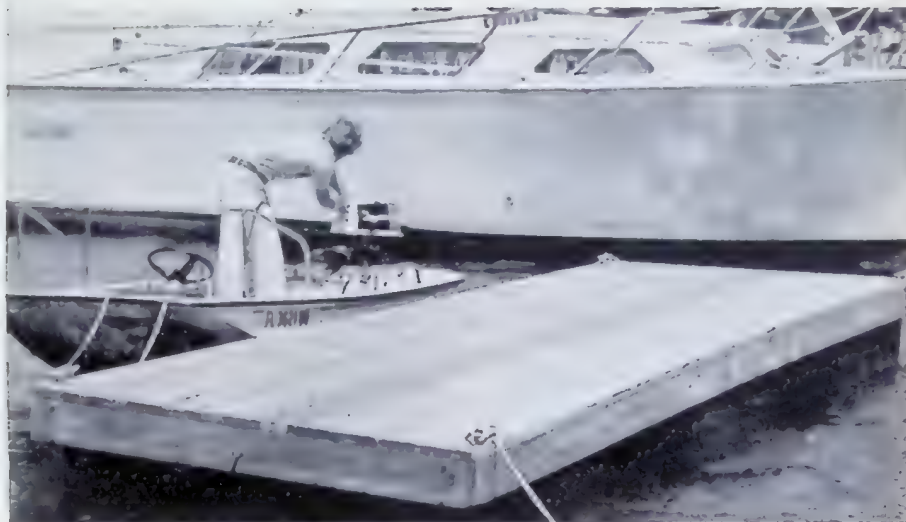


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Floating dock:

frame your own deck
around molded floats



Home-built wood deck, six by 20 feet, rests on a half-dozen factory-molded

plastic floats filled with foam. You use one section alone or link several.

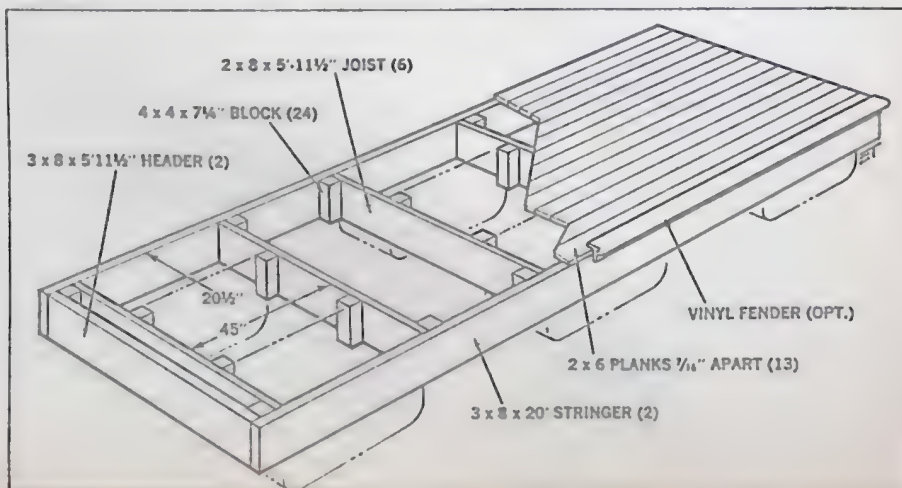
You build a simple deck of pressure-treated lumber (sketch below) and fit molded-plastic floats into its pockets. With four floats the dock supports about 1700 lb.; with six floats it handles over 2500.

Robert C. Cox of Hemisphere Marine, Ft. Lauderdale, Fla., who designed the six-by-20-ft. dock shown here, first built one four-by-18. But the narrower unit—with its two-by-four-ft. floats set crosswise instead

of lengthwise—felt unstable, Cox reports. But several four-foot-wide floats linked together would make a steady dock, he says.

Ask your lumber dealer for pressure-treated lumber; Cox recommends No. 1 yellow pine treated to a retention of 0.40. All deck fasteners should, of course, be galvanized.

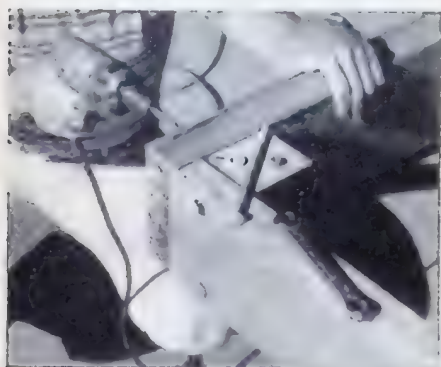
Made by U.S. Steel Chemicals, the seamless Poly Floats are molded of high-density polyethylene and



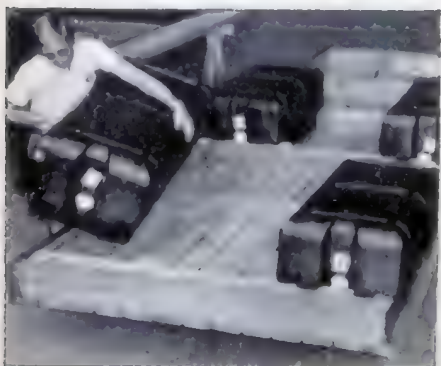
filled with closed-cell polystyrene foam. The hard shell is said to be highly resistant to punctures and impervious to gasoline, oil, common chemicals, salt water, and extreme temperatures. There are no metal parts to rust; also plastic won't conduct electrolytic currents, and is resistant to marine growth such as barnacles.

A distribution system is being set up for Poly Floats, which list at \$98 each. For the nearest retail source, write U.S.S. Chemicals, 500 Roeske Ave., Michigan City, Ind. 46360.

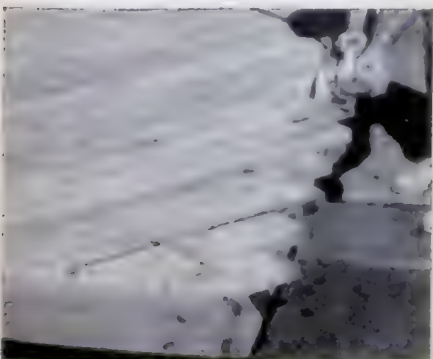
This dock has an eye on each end for towing, four cleats for boat lines. You can add a fender molding around the edge, and even a partial railing.—*Erik H. Arctander*



Rust-free corner joint: $\frac{3}{8}$ -in. galvanized carriage bolts in four-by-four blocks.



Poly Floats fit snugly—bolting's optional. A float weighs 36 lb., supports 700.



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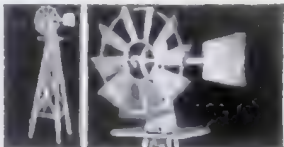
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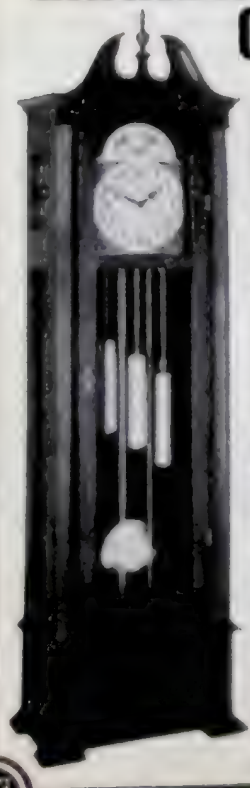
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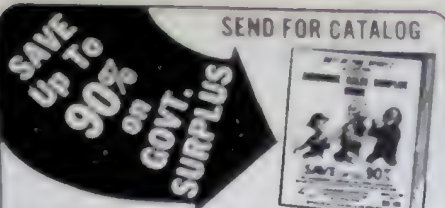


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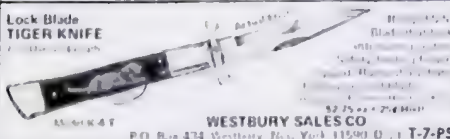
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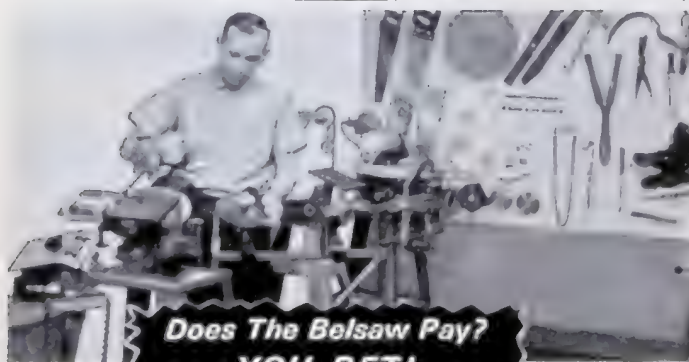
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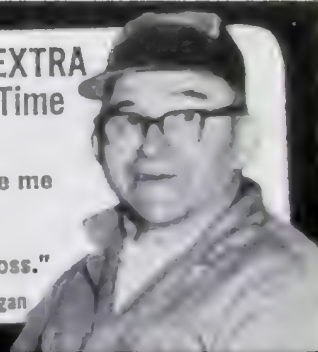
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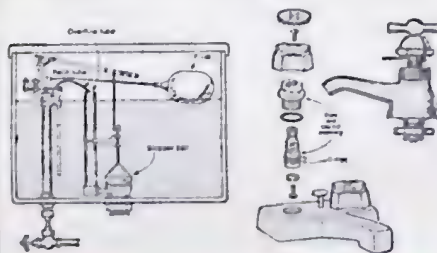
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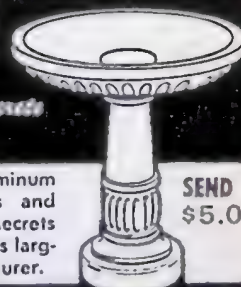
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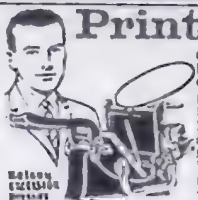
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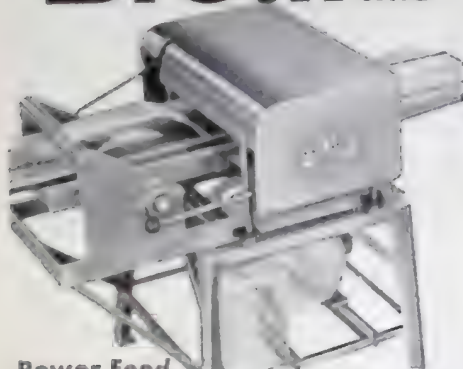


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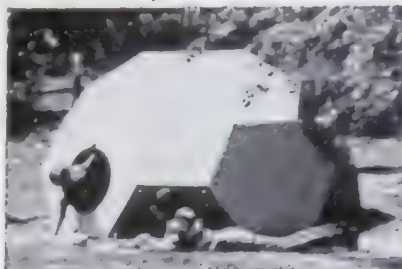
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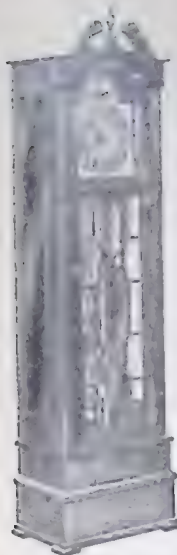
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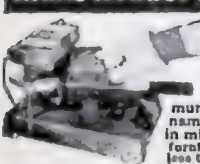
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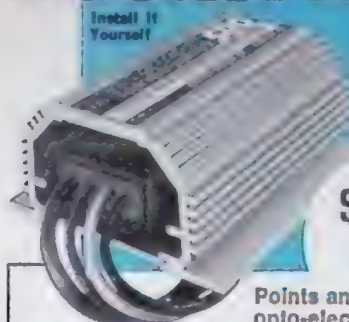
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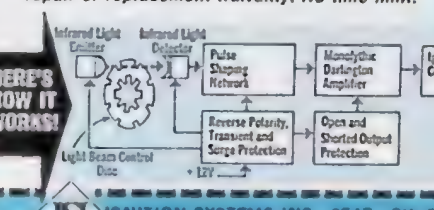
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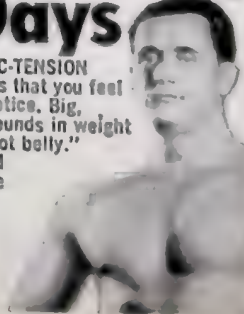
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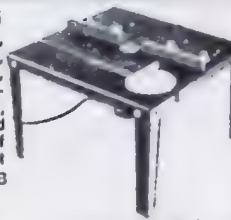
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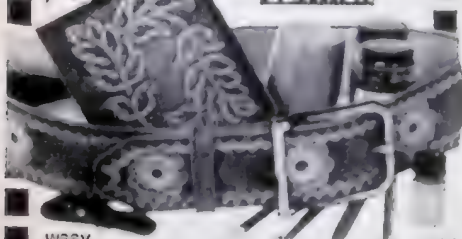
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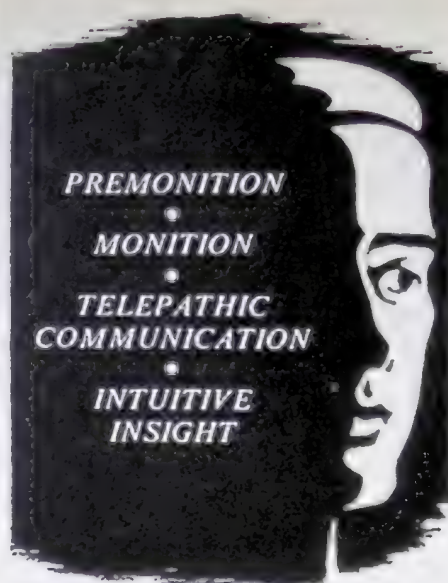
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175 (BR70)	13	35 64	1.99	175HR14	40.02	1.95	
175 (CR70)	14	37.90	2.10	165HR15	42.79	1.97	
185 (ER70)	14	40.81	2.30				
195 (FR70)	14	43.46	2.57	165HR13	35.35	1.65	
205 (GR70)	14	47.23	2.77	165HR14	36.55	1.75	
215 (HR70)	14	51.58	2.95	175HR14	42.50	1.85	
205 (GR70)	15	50.13	2.93	165HR15	39.64	1.80	
215 (HR70)	15	53.35	3.16	165HR15	50.11	2.30	
225 (JR70)	15	55.70	3.33				
230 (LR70)	15	63.83	3.40				
235 (LR70)	15	68.43	3.51				

MICHELIN IX				MICHELIN XWW			
Quan	Tubeless	IX	Price F.E.T.	Quan	Tubeless	WW	Price F.E.T.
145SR10	21.11	1.04		155/70VR14	86.01	2.64	
155SR12	27.60	1.39		205/70VR14	92.63	2.82	
145SR13	23.34	1.25		185/70VR15	85.59	2.50	
155SR13	27.15	1.48		215/70VR15	101.76	3.07	
165SR13	28.77	1.61					
175SR13	32.09	1.80		Quan Tube Type BW Price F.E.T.			
165/70SR13	31.87	1.54		205VR14	93.14	3.04	
175/70SR13	35.70	1.75		185/70VR15	79.64	2.53	
185/70SR13	39.52	2.04					
165SR14	34.62	1.60					
175SR14	35.91	1.59					
185SR14	36.76	2.24					
185/70SR14	42.14	2.17					
155SR15	33.17	1.65					
165SR15	37.36	1.79					

MICHELIN XVN				MICHELIN TUBES			
Quan	Tubeless	VN	Price F.E.T.	Quan	Tube Type	BW	Price F.E.T.
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155/70HR14	58.47	2.33		14-15 inch, thru 165	5.65 Ea.	
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Quan Tube Type BW Price F.E.T.				Price includes F.E.T. and freight			
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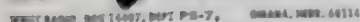
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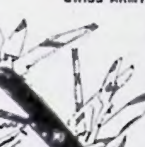
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| <input type="checkbox"/> 717 (50¢) | <input type="checkbox"/> 721 | <input type="checkbox"/> 725 | <input type="checkbox"/> 729 | <input type="checkbox"/> 733 (25¢) | <input type="checkbox"/> 737 (25¢) |
| <input type="checkbox"/> 718 (35¢) | <input type="checkbox"/> 722 (\$2) | <input type="checkbox"/> 726 | <input type="checkbox"/> 730 (\$1.50) | <input type="checkbox"/> 734 (50¢) | <input type="checkbox"/> 738 |

\$_____ for priced items

.25 for handling

\$_____ TOTAL REMITTANCE

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Anything else is mock turtle.